Indian Journal of Weed Science **53**(4): 367–373, 2021

Print ISSN 0253-8040 Online ISSN 0974-8164

Effect of different fertiliser levels and herbicide treatments on weeds and wheat

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Article information

DOI: 10.5958/0974-8164.2021.00068.X

Type of article: Research article

Received : 26 July 2021
Revised : 21 October 2021
Accepted : 23 October 2021

KEYWORDS

Clodinafop-propargyl, Metsulfuron-ethyl, Economics, Fertiliser management, Ready-mix herbicide, Weed management, Wheat

ABSTRACT

A field experiment was conducted during (winter) *Rabi* seasons of 2018-19 and 2019-20 at College of Agriculture, Jodhpur, Rajasthan with an objective to assess the effect of three fertiliser levels and seven weed management treatments on weeds and wheat to maximise productivity and profitability of wheat (*Triticum aestivum* L.) by effective and economical weed management. The total weed density was not influenced by increase in fertiliser rate. Significantly minimum weed biomass was recorded with the application of 75% of recommended dose of fertilisers (RDF) (90-30 kg N-P/ha). The 100% RDF (120-40 kg N-P/ha) application recorded significantly higher weed biomass, wheat growth indices (wheat growth rate, leaf area index net assimilation rate), grain, straw and biological yield than75% RDF and was at par with 125% RDF (150-50 kg N-P/ha). The post-emergence application (PoE) of clodinafop-propargyl 15% + metsulfuron-methyl 1% (ready-mix) 64 g/ha and sulfosulfuron 75% + metsulfuron-methyl 5% (ready-mix) 32 g/ha resulted in higher weed control efficiency, lower weed index with higher value of crop resistance index (CRI) and herbicide efficiency index (HEI). The use of 100% RDF with clodinafop-propargyl + metsulfuron-ethyl (ready-mix) 64 g/ha PoE recorded higher net returns and maximum B:C ratio.

INTRODUCTION

Wheat is the 2nd staple food crop, next to rice, in India with acreage and production of 30.60 Mha and 107.18 mt, respectively (GOI 2021). In Rajasthan, it is cultivated on 3.50 Mha area with production of 13.88 MT and productivity of 3971 kg/ha (Commissionerate of Agriculture 2021). Weeds are major constraints in wheat production and they reduce productivity by 42.8% (Singh and Singh 2004) due to competition and allelopathy. Weeds cause 17–30% losses in wheat annually (Bisen *et al.* 2006). Thus, the weeds management is a basic requirement for higher production in the wheat production system. Hand weeding which is very effective but it is not only laborious and insufficient but also expensive and accounts for about 25% of total labor force used which amounts to about 900–1200-man hours/ha (Nadeem *et al.* 2008, Nag and Dutt 1979). The manual weeding is not feasible in narrow row crops. Thus, herbicides usage is most commonly used, reliable, quick, more effective, time and labour-saving method (Kumar 2009) for managing weeds in wheat. Due to complexity and diversity of weed flora, more than one herbicide is required either in sequence or as mixture for weed management. Weed management is likely to become more complex due to increase in their invasiveness, herbicides resistance in weeds, weed shifts and their residue hazards under changing climate (Barman *et al.* 2014). Selective herbicides control limited weed species but may not be useful on complex of weed flora. There is ample scope for controlling weeds by application of post-emergence herbicides mixtures.

Alfisols of Western Rajasthan are deficient in nitrogen and phosphorus nutrients and farmers supply these nutrients in the form of fertilizers for normal growth and development of plants. Nitrogen is the important nutrient and its deficiency often limits crop production. Weed density, diversity index and community structure of farmland are significantly affected by soil nutrient content. Manipulation of crop fertilization is a promising cultural practice to reduce weed interference in crops so that nutrient uptake by crops can be maximized and increase the competitive ability of crops against weeds. Fertilizer usage increases crop yield and it is associated with simultaneous increase in the weeds growth with enhanced uptake of nitrogen, phosphorus and potash by weeds compared to wheat crop. Thus, weed management is critical for optimal wheat yield to enable crop to use applied nutrient resources. The efficacy of herbicides on weeds is influenced by several variables, including weed biology, weed ecology, soil fertility, soil moisture and selected nutrients usage. Thus, the present study was conducted to identify effective and economically viable dosage rates of fertilizers and herbicides for managing weeds and enhancing the productivity of wheat.

MATERIALS AND METHODS

The field experiment was carried out during two consecutive *Rabi* (winter) seasons of 2018-19 and 2019-20 at the Instructional Farm, College of Agriculture-Jodhpur, Rajasthan, India. Geographically, it is located between 26° 15' N to 26° 45' North latitude and 73° 00' E to 73° 29' East longitude at an altitude of 231 meters above mean sea level. This region falls under agro-climatic zone Ia (Arid Western Plains Zone) of Rajasthan. The average annual rainfall is about 367 mm and bulk of it (85 to 90 %) is received from June to September (rainy season) by the South-West monsoon. The mean daily maximum and minimum temperatures varied between 20 to 28.8 °C and 10.1 to 20.0 °C, respectively in 2018-19 and the corresponding values in the year 2019-20 were 15 to 25.9 °C and 5.4 to 18.0 °C during the crop growing seasons. The soil of the experimental fields was loamy sand in texture, slightly alkaline in soil reaction, low in organic carbon (0.12 to 0.14%), low available nitrogen (174 to175 kg/ha), medium available phosphorus (20.3 to 21.0 kg/ha), high in available potassium (324 to 325 kg/ha). Wheat variety '*GW 11*' was sown at a row to row spacing of 22.5 cm using 100 kg seeds/ha on 20 November 2018 and 18 November 2019.

The experiment was laid out using split plot design with three replications. The treatments comprised of three levels of fertiliser application in main plots viz., 75% of recommended dose of fertiliser (RDF) (90-30 kg N-P/ha), 100% of RDF (120-40 kg N-P/ha) and 125% of RDF (150-50 kg N-P/ha)] and seven different weed management treatments in sub plots *viz*., post-emergence application (PoE) of trisulfuron 15 g/ha at 35 days after seeding (DAS), sulfosulfuron 75% + metsulfuron-methyl 5% (ready-mix) 32 g/ha PoE at 35 DAS, clodinafop-propargyl 15% + metsulfuron-methyl 1% (ready-mix) 64 g/ha PoE at 35 DAS, carfentrazon 20 g/ha PoE at 35 DAS, metsulfuron-methyl 4 g/ha PoE at 35 DAS, weedy check and weed free. Fertiliser rates were applied using DAP and urea as a source of P and N. Half of N and full dose of P were applied as basal dose at the time of sowing. Remaining quantity of N was applied as top dressing in standing crop through urea in two equal split doses at the time of first and second irrigation. All the tested herbicides were applied at 35 DAS using flat fan nozzle & foot sprayer with spray volume of 600 litres of water per hectare. Weed free plots were weeded regularly to keep them weed free throughout the crop period.

The observations on total weed density (number/m^2) and weed dry weight (weed biomass) (g/m^2) was recorded under each treatment with the help of 0.25 m^2 quadrat and presented as per m^2. Data on total weed density and biomass were transformed using ($\sqrt{(x+0.5)}$ for comparison of treatments. Weed control efficiency (WCE), weed index (WI), herbicide efficiency index and (HEI) crop resistance index (CRI), leaf area index (LAI), crop growth rate (CGR) and net assimilation ratio (NAR) was calculated by using the standard formulae. The experimental data recorded in various observations were statistically analysed in accordance with the 'Analysis of Variance' technique as described by Panse and Sukhatme (1985). The least significant difference (LSD) was calculated for the comparison among treatments where ever the variance ratio (F test) was found significant at 5% level of probability. To elucidate the nature and magnitude of treatments effects, summary tables along with LSD (p=0.05) were prepared.

RESULTS AND DISCUSSION

Effect on weed density and biomass

Weed flora of the experimental field consisted of *Chenopodium murale, Chenopodium album, Rumex dentatus, Asphodelus tenuifolius, Melilotus alba, Melilotus indica, Fumaria parviflora, Cynodon dactylon, Launaea asplenifolia* and *Cyperus rotundus* during both the years of experimentation. The broad-leaved weeds were more dominant than grassy and sedge weeds.

The total weed density recorded (**Table 1**) at 35 and 50 DAS was not affected significantly by fertiliser levels during both the years. Application of 75% RDF resulted in significantly lower weed biomass at 50 DAS (16.01 and12.33 g/m^2). The increase fertiliser rates up to 125% significantly increased weed biomass at 50 DAS during both the years. An increase in weed biomass of 18.18 and 23.79% in the first year and 12.58 and 29.11% in second year was observed at 50 DAS with 125% RDF when compared to 100% and 75% RDF, respectively. This increase in weed biomass with increasing fertiliser dose might be attributed to better growth environment due to ample availability of nutrients both for weeds and wheat as reported by Chauhan *et al*. (2017) and Gupta *et al*. (2019). Balasubramanian and Palaniappan (2004) observed that additional fertilizer application may benefit weeds to a higher extent than crop because nutrient absorption is faster and higher in weeds than in crop plants.

All herbicidal treatments significantly reduced weed density and biomass compared with weedy check plot (control) which recorded maximum weed density and biomass (**Table 1**). Among herbicides, clodinafop-propargyl + metsulfuron-methyl (ready-mix) at 64 g/ha PoE proved most effective in lowering weed density 8.89 and 5.22/m^2 and biomass at 50 DAS 7.94 and 6.16 g/m^2 during 2018 and 2019, respectively. It remained at par with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE. The metsulfuron-methyl 4 g/ha PoE was next best in minimising weed biomass. A significant reduction in weed density (95.46 and 96.91% in first and second season, respectively) and biomass (85.91 and 85.76% in first and second season, respectively) was observed with clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE, over weedy check. Metsulfuron-methyl was effective in managing weeds of wheat due to greater dominance of broad-leaved weeds in the experimental field. The use of broad-spectrum herbicidal combinations was proven more effective as it gave complete control of weeds associated with wheat as reported earlier by Singh *et al.* (2015) and Bharat *et al.* (2012).

Effect on weed indices

The highest weed control efficiency (**Table 2**) was achieved by clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE (90.37%) during first season while in second season it was recorded with sulfosulfuron + metsulfuron-methyl (ready-mix) PoE 32 g/ha (92.47%). Similar reports were made by Kumar *et al.* (2012); Malik *et al.* (2013) and Raj *et al.* (2020).

The lowest weed index of 1.40 and 2.40% were recorded by application of clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE whereas the second lowest weed index of 7.15 and 3.08% was recorded with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE during 2018 and 2019, respectively. Weed index is an ideal framework to depict yield loss caused by weed infestation in comparison with weed free plots (Suria *et al*. 2011) and a minimum value of weed index means high herbicide efficiency resulting higher yield of wheat. The clodinafop-propargyl + metsulfuron-methyl (ready-mix) PoE 64 g/ha produced highest

Table 1. Effect of fertilizer rates and weed management treatments on total weed density and biomass

Treatment	Total weed density (no./m^2)				Total weed biomass (g/m^2)			
	Before spray (35 DAS)		After spray (50 DAS)		Before spray (35 DAS)		After spray (50 DAS)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Fertiliser level (N:P) kg/ha								
75% recommended dose of fertilisers (RDF) (90:30)	10.44(125)	10.25(120)	6.05(56.1)	5.38(45.9)	3.61(14.1)	3.31(11.7)	3.60(16.0)	3.17(12.3)
100% RDF (120:40)	10.70(131)	10.19(119)	6.20(56.6)	5.65(50.2)	4.22(19.4)	3.56(13.6)	3.71 (16.8)	3.41(14.1)
125% RDF (150:50)	10.97(137)	10.41(124)	6.22(59.5)	5.59(48.2)	4.28(20.1)	3.65(14.4)	3.96(19.8)	3.61(15.9)
LSD (p=0.05)	NS	NS	NS	NS	0.272	0.202	0.177	0.199
Weed management								
Trisulfuron 15 g/ha 35 DAS	12.47(155)	11.84(140)	11.06(123)	9.71(94.9)	4.64(21.3)	3.90(14.8)	5.09(25.6)	4.75(22.4)
Sulfosulfuron + metsulfuron-methyl 32 g/ha at 35 DAS	11.94(147)	12.13(143)	2.83(7.6)	2.30(4.9)	4.72(22.2)	3.94(15.2)	2.95(8.2)	2.53(6.0)
Clodinafop-propargyl + metsulfuron-methyl 64 g/ha at 35 DAS	12.23(150)	11.76(138)	3.04(8.9)	2.38(5.2)	4.50(20.1)	3.70(13.2)	2.90(7.9)	2.57(6.2)
Carfentrazon 20 g/ha at 35 DAS	12.71(161)	12.10(147)	6.63(43.6)	7.09(50.0)	4.73(22.1)	4.16(17)	3.77(13.8)	3.64(12.8)
Metsulfuron-methyl 4 g/ha at 35 DAS	12.45(155)	11.76(138)	4.84(23.0)	3.60(12.6)	4.37(18.8)	4.06(16.1)	3.36 (10.8)	2.95(8.2)
Weedy check	12.20(149)	11.86(141)	13.99(196)	12.99(169)	4.58(20.6)	4.09(16.3)	7.53(56.4)	6.61(43.3)
Weed free	0.71(0)	0.71(0)	0.71(0)	0.71(0)	0.71(0)	0.71(0)	0.71(0)	0.71 (0)
LSD (p=0.05)	0.647	0.629	0.266	0.347	0.264	0.208	0.164	0.195

*Original values given in parentheses was subjected to square root transformation ($\sqrt{(x+0.5)}$) before analysis; DAS: days after seeding

HEI (0.228 and 0.215) (**Table 2**) in both the study seasons. These results corroborate the findings of Khaliq *et al.* (2011). A higher HEI value indicates greater efficiency of the weed management treatment. Maximum crop resistance index at harvest was also recorded with clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE closely followed by sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE and metsulfuron-methyl 4 g/ ha PoE.

Effect on wheat growth indices

The CGR, LAI and NAR are the important growth parameters influencing yield which are dependent not only on the genotype but also on the environmental and fertility management practices. Different levels of fertility and herbicidal treatments depicted a positive influence on wheat growth analysis parameters, *viz*., CGR, LAI, and NAR (**Table 3**). The maximum values of these growth indices were recorded with the 125% fertility level followed by 100% RDF. The significantly higher value of CGR at 35-50 DAS (23.74 and 23.58 g/m^2/day) and at 50-75 DAS (16.66 and 17.49 g/m^2/day) was recorded in case of 100% RDF over 75% RDF. Application of 125% RDF registered highest LAI *i.e.,* 4.08 and 4.57 which were on par with 100% RDF. These findings were in close agreement with the finding of Shukla and Warsi (2002); Laghari *et al.* (2010); Chatterjee *et al.* (2016). Sharma *et al.* (2012) and Parewa *et al.* (2018) also reported that higher fertility levels, adequate supply of nutrients favoured the nutrient uptake and nutrient utilization towards protein which favoured vertical and lateral growth of the crop plants and ultimately increased the area of leaves, as evident from significant increase in leaf area index with increasing fertility levels.

Among herbicides, the maximum crop growth rate between 35-50 and 50-75 DAS was recorded with application of clodinafop-propargyl + metsulfuron-methyl PoE 64 g/ha (22.29 and 16.40 g/ m^2/day) and it was at par with metsulfuron-methyl 4 g/ha PoE (21.45 and 19.35 g/m^2/day) and

Table 2. Effect of weed management treatments on weed control efficiency, weed index, herbicide efficiency index and crop resistance index

Treatment	Weed control efficiency (%)		Weed index (%)		Herbicide efficiency index		Crop resistance index at harvest	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Trisulfuron 15 g/ha at 35 days after seeding (DAS)	67.44	70.63	24.98	22.56	0.098	0.113	3.72	4.12
Sulfosulfuron + metsulfuron-methyl 32 g/ha at 35 DAS	89.92	92.47	7.15	3.08	0.198	0.204	14.76	19.79
Clodinafop-propargyl + metsulfuron-methyl 64 g/ha at 35 DAS	90.37	92.28	1.40	2.40	0.228	0.215	15.44	19.86
Carfentrazon 20 g/ha at 35 DAS	85.12	84.56	20.05	18.18	0.143	0.145	8.65	8.05
Metsulfuron-methyl 4 g/ha at 35 DAS	87.37	88.75	10.34	9.03	0.202	0.203	10.40	11.83
Weedy check	0.00	0.00	33.84	32.53	0.000	0.000	1.00	1.00
Weed free	100.00	100.00	0.00	0.00	0.237	0.224	0.00	0.00

Table 3. Effect of fertiliser levels and weed management treatments on crop growth rate, leaf area index and net assimilation rate

Treatment	CGR (g/m^2/day)				LAI		NAR (g/m^2 leaf area/day)	
	35-50 DAS		50-75 DAS		75 DAS		50-75 DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Fertiliser levels (N:P) kg/ha								
75% recommended dose of fertilisers (RDF) (90:30)	10.27	9.56	9.55	10.08	3.19	3.67	4.05	3.55
100% RDF (120:40)	23.74	23.58	16.66	17.49	3.79	4.22	5.84	5.29
125% RDF (150:50)	24.69	24.75	16.83	17.66	4.08	4.57	5.72	5.04
LSD (p=0.05)	2.273	2.242	5.903	5.733	0.45	0.42	2.405	1.795
Weed management								
Trisulfuron 15 g/ha at 35 days after seeding (DAS)	17.82	17.56	11.15	12.04	3.62	4.05	4.39	3.88
Sulfosulfuron + metsulfuron-methyl 32 g/ha at 35 DAS	21.43	21.47	16.10	16.49	3.88	4.36	5.52	4.81
Clodinafop-propargyl + metsulfuron-methyl 64 g/ha at 35 DAS	22.29	23.02	16.40	16.59	3.79	4.32	5.70	4.90
Carfentrazon 20 g/ha at 35 DAS	18.74	18.51	14.46	15.21	3.60	4.21	5.36	4.65
Metsulfuron-methyl 4 g/ha at 35 DAS	19.35	19.32	15.96	16.02	3.91	4.30	5.30	4.67
Weedy check	13.68	13.09	9.16	10.74	2.87	3.40	4.57	4.33
Weed free	23.65	22.13	17.19	18.45	4.12	4.47	5.57	5.23
LSD (p=0.05)	3.392	3.627	4.565	4.358	0.37	0.45	1.794	1.540

sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE (21.43 and 19.33 g/m^2/day) during 2018-19 (**Table 3**). Similar pattern of CGR was observed during second season of study. The maximum LAI (4.12 and 4.47) was obtained under weed free treatment during both the seasons (**Table 3**). Among herbicidal treatments, highest leaf area index was recorded with metsulfuron-methyl 4 g/ha (3.91) in 2018 and with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha (4.36) in 2019. These results were closely in conformity with previous study of Kumar *et al*. (2018). Application of clodinafop-propargyl + metsulfuron-methyl (ready-mix) PoE 64 g/ha resulted in highest NAR however, it was at par with all other treatments except metsulfuron-methyl at 4 g/ha and weedy check during first year. During second year, all herbicides were on par to each other. Our results were in closed conformity with the findings of Meena *et al*. (2019) and Mishra *et al*. (2016).

Effect on wheat grain, straw and biological yield

Application of 125% RDF gave significantly higher grain yield and it was at par with 100% RDF, during both the years (**Table 4**). The increasing RDF from 75-100% resulted in significant improvement in grain yield by 23.5 and 18.6%, respectively during first and second season. The increase in fertiliser level from 100-125% RDF did not influence the grain yield. The straw yield increased significantly upto100% RDF during first season and upto125% during second season The application of 100% RDF resulted in higher straw yield by 21.2% over 75% RDF during 2018-19. In second season, 14.2 and 25.20%, increase in straw yield was observed with increased fertiliser dose from 75-100% RDF and 100-125%, respectively. An increase in total biomass of 16.4 and 24.9% in first and second season, respectively was recorded when the fertiliser rate was increased from 75% RDF to 125% RDF. There was no significant difference in harvest index among all fertility levels during both seasons. Adequate availability of nitrogen and phosphorus in soil at the time of tillering might have resulted in higher numbers of tillers. The higher yield attributes might also be due to better availability of nitrogen resulting faster translocation of photosynthates from leaves to sink site *i.e.* spike and grain via stem. (White and Veneklaas 2012). Similar observations of higher grain yield with increased fertiliser dose were made by Samimi and Thomas (2016); Chauhan *et al.* (2017); Jat *et al.* (2013) and Nadeem *et al.* (2016).

The clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE gave grain yield that was at par with weed free check and sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE during first year. In second year, clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ ha PoE was at par with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE (4.32 t/ha) and metsulfuron-methyl (ready-mix) 4 g/ha PoE (4.13 t/ha). Significantly negative correlation (r = - 0.812 and - 0.828) was observed between grain yield and weed biomass at 50 DAS (**Figure 1**).

Economic analysis

Higher net returns were recorded with 100% RDF (₹ 69,775/ha) and B:C ratio (2.67) during first

Table 4. Effect of fertiliser levels and weed management treatments on wheat grain, straw and biological yield and harvest index

Treatment	Wheat grain yield (t/ha)		Wheat straw yield (t/ha)		Biological yield (t/ha)		Harvest index (%)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Fertiliser level (N:P) kg/ha								
75% recommended dose of fertilisers (RDF) (90:30)	3.29	3.46	4.18	4.35	7.47	7.82	44.01	44.23
100% RDF (120:40)	4.06	4.11	5.07	4.97	9.13	9.08	44.41	45.22
125% RDF (150:50)	3.93	4.31	4.77	5.45	8.70	9.76	45.14	44.04
LSD (p=0.05)	0.41	0.40	0.52	0.47	0.92	0.48	NS	NS
Weed management								
Trisulfuron 15 g/ha at 35 days after seeding (DAS)	3.27	3.52	4.17	4.40	7.44	7.91	43.95	44.42
Sulfosulfuron + metsulfuron-methyl 32 g/ha at 35 DAS	4.06	4.32	4.98	5.41	9.04	9.73	44.87	44.34
Clodinafop-propargyl + metsulfuron-methyl 64 g/ha at 35 DAS	4.32	4.43	5.26	5.50	9.58	9.94	45.00	44.52
Carfentrazon 20 g/ha at 35 DAS	3.49	3.72	4.42	4.65	7.91	8.37	44.15	44.37
Metsulfuron-methyl 4 g/ha at 35 DAS	3.92	4.13	4.84	5.05	8.75	9.18	44.77	44.94
Weedy check	2.89	3.06	3.67	3.92	6.56	6.98	44.06	43.87
Weed free	4.37	4.54	5.38	5.55	9.74	10.09	44.82	45.03
LSD (p=0.05)	0.34	0.36	0.38	0.39	0.67	0.67	NS	NS

Table 5. Effect of fertiliser levels and weed management treatments on economics of wheat

Treatment	Net returns (x10^3 `/ha)		B:C ratio	
	2018-19	2019-20	2018-19	2019-20
Fertiliser level (N:P) kg/ha				
75% recommended dose of fertilisers (RDF) (90:30)	49.89	57.19	2.22	2.42
100% RDF (120:40)	69.78	73.50	2.67	2.78
125% RDF (150:50)	64.53	79.78	2.52	2.90
LSD (p=0.05)	11.20	7.70	0.27	0.19
Weed management	0.00	0.00		
Trisulfuron 15 g/ha at 35 days after seeding (DAS)	50.63	59.71	2.27	2.52
Sulfosulfuron + metsulfuron-methyl 32 g/ha at 35 DAS	70.08	81.51	2.71	3.01
Clodinafop-propargyl + metsulfuron-methyl 64 g/ha at 35 DAS	76.96	84.36	2.88	3.08
Carfentrazon 20 g/ha at 35 DAS	56.27	65.15	2.40	2.64
Metsulfuron-methyl 4 g/ha at 35 DAS	67.58	76.52	2.70	2.94
Weedy check	40.96	48.14	2.05	2.25
Weed free	67.33	75.69	2.29	2.46
LSD (p=0.05)	8.56	9.12	0.20	0.22

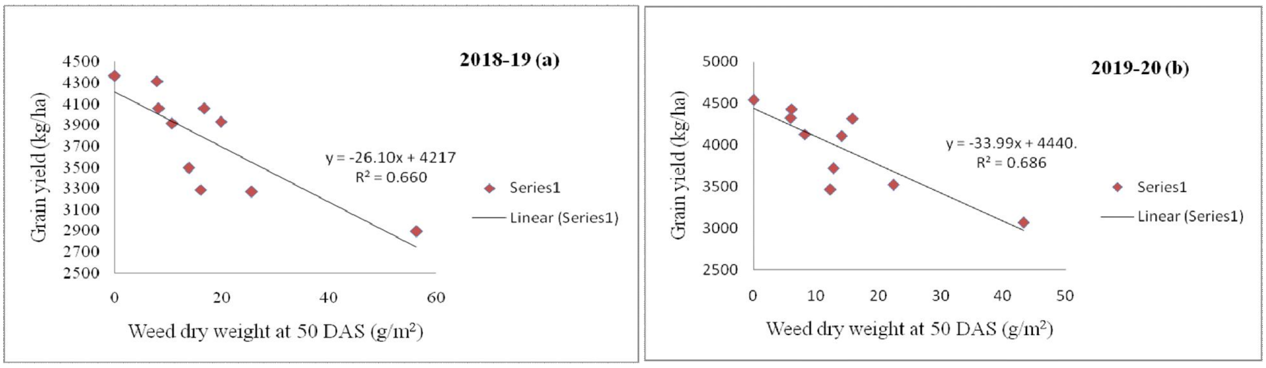

Figure 1. The linear regression between grain yield and weed biomass at 50 days after seeding during a: 2018-19 and b: 2019-2020

year while in second year, the highest net returns (₹ 79,777/ha) and B:C ratio (2.90) were recorded under application of 125% RDF (**Table 5**). The clodinafop-propargyl + metsulfuron-methyl 64 g/ha PoE recorded maximum net returns of ₹ 76,961/ha and it was at par with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE during first season. During second season of study, application of clodinafop-propargyl + metsulfuron-methyl (ready-mix) 64 g/ha PoE recorded maximum net returns of ₹ 84,359/ha and was at par with sulfosulfuron + metsulfuron-methyl (ready-mix) 32 g/ha PoE (₹ 81,508/ha) and metsulfuron-methyl 4 g/ha PoE (₹ 76,523/ha). Application of 100% RDF recorded B: C ratio of 2.67 and 2.78 in 2018-19 and 2019-20, respectively. The cost was reduced in herbicidal treatments due to lesser use of human labour.

The post-emergence application of clodinafop-propargyl 15% + metsulfuron-methyl 1% (ready-mix) 64 g/ha at 35 DAS along and 100% RDF could be used for effective management of weeds and higher productivity of wheat in arid climatic condition of Rajasthan.

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