ZANCO Journal of Pure and Applied Sciences
The official scientific journal of Salahaddin University-Erbil
https://zancojournals.su.edu.krd/index.php/JPAS

ISSN (print):2218-0230**, ISSN (online):** 2412-3986**, DOI: http://dx.doi.org/10.21271/zjpas**

RESEARCH PAPER

Efficacy of Herbicide Combinations and Seeding Rates on Growth and Yield of Bread Wheat and its Associated Weeds

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A B S T R A C T:

herbicides have the considerable influence on weed control especially when combined with other herbicides and different seeding rates as an integrated weed management in wheat fields. This study was carried out to evaluate the effects of two herbicides with different concentrations as combinations. First, Atlantis 240 gm. ha^{-1} + Granstar 35 gm. ha^{-1} (low dose) second Atlantis 320 gm. ha^{-1} + Granstar 50 gm. ha^{-1} (recommended dose) third Atlantis 400gm. ha^{-1} + Granstar 65 gm. ha^{-1} (higher dose) comparing with weedy check and weedy free plots as a control treatments, and different seeding rates (75, 100, 125 kg. ha^{-1}) on bread wheat at two different locations (Grdarasha and Ainkawa) and were distributed with three replicates using the randomized complete block design (RCBD). The results indicated that wheat grain yield had the highest value was 8.9 ton. ha^{-1} by low dose of Atlantis. 240 gm. ha^{-1} + Granstar. 35 gm. ha^{-1} at Grdarasha where at Ainkawa was 6.29 ton. ha^{-1} by high dose of Atlantis. 400 gm. ha^{-1} + Granstar. 65 gm. ha^{-1} herbicides. In addition, seeding rates had significant impacts on wheat grain yield, which it was achieved highest grain yield at higher seeding rates at both locations. Whereas, herbicide combinations of higher dose of Atlantis. 400 gm. ha^{-1} + Granstar. 65 gm. ha^{-1} reduced total weed number and weight significantly to the lowest value at both locations. As well as highest seeding rates of bread wheat had minimum total weed number and weight at both locations. Herbicide combinations with higher seed rate of economic crops together can control weeds more efficiently in wheat fields.

KEY WORDS: herbicide combinations, seeding rates, weed control, wheat
DOI: http://dx.doi.org/10.21271/ZJPAS.35.3.12
ZJPAS (2023) , 35(3);135-152 .

1. INTRODUCTION:

Wheat (*Triticum aestivum L.)* is one of the most important food crops of the world and a member of the family Poaceae that includes major cereal crops of the world such as maize, wheat and rice (Belete et al., 2018). Weeds, diseases, abiotic stresses, insect pests, and imbalanced crop nutrition are the main causes of yield loss, especially weed infestation, which is considered a major threat to agricultural systems causing significant loss in yield (Semenov and Halford, 2009). Such greater loss of yield referred to competition for growth sources like; light, nutrition, and space, as well as allelochemical substances secreted by weed plants and roots, which inhibit crop growth,

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Article History:
Received: 06/09/2022
Accepted: 05/12/2022
Published: 15/06 /2023

furthermore weed plants work as a host for insects and disease organisms that negatively acting on cereal crops (Monaco et al., 2002, Rana and Rana, 2016, Naby and Ali, 2020b) . Weed control is a necessary tool in crop production because of remarkable economic losses in crop yield (Naby and Ali, 2020a).Scientific research observed that the wheat yield loss and the wheat economic yield loss due to weed infestation annually reach 34% and 18% respectively (Chaudhary et al., 2008, Flessner et al., 2021, Gharde et al., 2018). Weed control in wheat is crucial during the early stages, up to 30-40 days. Various techniques can be used to control weeds. However, each weed-control strategy has its own set of limitations (Singh et al., 2006, Soliman et al., 2011)**.** Chaudhary et al. (2008), (Kumar et al., 2013, Meena et al., 2016) demonstrated that

chemical weed control is recommended over other weed control methods because it is faster, more efficient, and relatively less expensive. However, extreme dose and unsuitable use of herbicide lead to develop tolerance of weeds toward herbicides as it was known this phenomenon weed herbicide resistance (Kruidhof et al., 2008, Walker et al., 2013). (Chattha, 2014, Tiwari et al., 2011) Illustrated that all herbicides reduced weed population and significantly increased wheat yield and yield components when compared to the control.

Atlantis is a systemic herbicide that it works to inhibit the biosynthesis of amino acids and proteins, Atlantis herbicide is used for eliminating a wide range of weeds such as (*Chenopodium album, Malva spp, Melilotus spp, Polygonum articulate, Avena fatua, Lolium spp,* and *Phalaris spp)* (CropScience, 2022). The weed control percentage of the Atlantis herbicide had the highest value 88.35 % and the lowest weed dry weight was 35.6 gm.m^{-2} when compared to the comparison weedy check treatment (Al-Khafji et al., 2020). Tribenuron-methyl is used for control of broad-leaved weeds in cereal crops, including wheat, barley, oats, rye, and triticale(Mukherjee et al., 2015).Al-Wagaa and Mohammed (2020) showed that the combinations of (Tribenuron – methyl) with other herbicides were superior to the weedy check treatments because it produced the lowest weed density and dry weight (25.87 plant.m^{-2}, 36.70 gm.m^{-2}, respectively).

The optimum seeding rate of economic crops is another method to weed control in cereal crops because of plant population has a significant effect on weed plants and cereal crops yield. Kumar et al. (2016) observed that density and dry weight of weeds were influenced significantly by different seed rate, when increased seed rate from100 to 150 kg ha^{-1} decreased the density and dry weight of total weeds at all stages of crop growth during both the years. Sowing with 150 kg ha^{-1} seed rate recorded minimum density and dry weight of total weeds, which was significantly lower than 100 and 125 kg ha^{-1} seed rate.

The Interaction of herbicides and seeding rates have significant impact on weed biomass reduction. Mahmud et al. (2016) illustrated that highest value were (753.98) and (546.59) gm.m^{-2} for weed dry weight in interaction between weedy check and seeding rates (100 kg. ha $^{-1}$), (120 kg. ha^{-1}) respectively, while reduced total weed dry weight to (87.26) and (72.56) for plots was treated with interaction between Atlantis and seeding rates (100kg.ha $^{-1}$), (120 kg. ha^{-1}) respectively

In order to study the different weed control methods in wheat, this experiment was conducted at two locations with the objectives; to investigate the efficacy of different herbicides combination and seeding rates on weed control and determine the impact of weed control on wheat yield.

2.Material and methods

2.1 Description of the study area:

The experimental study was conducted during the winter season of the Iraqi Kurdistan region from 2021-2022 at two locations in Erbil governorate, the first location was Grdarasha Experimental Research Center/ college of agricultural engineering sciences/ University of Salahaddin-Erbil, and the second location was Erbil Directorate of Agricultural Research/ Ainkawa at (Lat. 36^{o} 7 N, Long. 44^{o} 0 E, Alt. 409 m) and (Lat. 36^{o} 14 N, Long. 43^{o} 59 E, Alt**.** 415 m) respectively both locations. Soil samples were analyzed for some physical and chemical properties by the Erbil Directorate of Agricultural Research/ Ainkawa. The results are shown in (**Table 1**). The meteorological data were obtained from a computerized meteorological station during the growing season; the results are shown in **Table2** The survey of most common weeds in study area showed in **table 3**.

Table 1: soil properties of the study area

Soil properties		locations	
		Grdarasha	Ainkawa
Physical properties	Sand %	31	19
	Silt %	37.3	43
	Clay %	31.7	38
	Soil texture	Clay loam	Silty clay loam
Chemical properties	EC(Ds/m)	0.50	0.30
	PH	7.83	7.86
	N%	0.07	0.11
	P(PPM)	12.5	8.62
	K(PPM)	338	200
	O.M%	1.14	0.90

Table 2: Meteorological Data of Studied Areas

Year/Month			2021		2022				
Parameters		Location	Nov	Dec	Jan	Feb	Mar	Apr	May
Air Temperature C°	Min	GR	8.14	0.68	-3.16	2.56	-0.21	6.6	11.5
		AN	3.27	-0.46	-4.52	-0.53	-1.6	3.94	8.98
	Max	GR	29.54	24.22	17.02	23.73	25.84	34.24	40.13
		AN	28.94	21.59	16.72	23.64	26.98	33.4	40.09
	Ave	GR	17.8	11.51	7.51	12.09	11.59	21.85	25.07
		AN	15.67	10.06	6.92	11.39	11.46	20.57	24.25
Average soil Temperature C°		GR	19.7	13.15	8.51	10.55	12.49	19.94	25.44
		AN	17.99	10.88	7.4	10.83	12.8	22.02	26.51
Average relative Humidity %		GR	5.655	59.45	67.27	52.47	50.25	30.16	30.56
		AN	43.262	67.82	71.9	58.34	52.32	37.01	32.96
Rainfall mm		GR	6.6	74.42	56.13	30.22	14.48	31.75	15.24
		AN	5.4	74.1	80.5	28.1	13	25.4	22.1

Note: GR and AN abbreviate for Grdarasha and Ainkawa location

Table 3 Most common Weeds community at both studied areas

Scientific name	Family name	Life cycle	Category	location
Fumaria officinalis L.	Papaveraceae	A. W	Broad leaf	Grdarasha
Veronica polita	Plantaginaceae	A. W	Broad leaf	Grdarasha
Brassica napus	Brassicaceae	A. W	Broad leaf	Grdarasha&Ainkawa
Lamium amplexicaule	Lamiaceae	A. W	Broad leaf	Grdarasha
Carthamus oxyacantha	Asteraceae	A. W	Broad leaf	Grdarasha&Ainkawa
Medicago polymorpha L.	Fabaceae	A	Broad Leaved	Grdarasha&Ainkawa
Convolvulus arvensis	Convolvulaceae	P	Broad leaf	Grdarasha
Apium graveolens	Apiaceae	B&P. W	Broad leaf	Grdarasha
Galium tricorne	Rubiaceae	A. W	Broad leaf	Grdarasha
Capsella bursa-pastoris	Brassicaceae	A. W	Broad leaf	Grdarasha&Ainkawa
Malva parviflora	Malvaceae	A	Broad leaf	Grdarasha&Ainkawa
Silybum marianum L.	Asteraceae	A. W	Broad leaf	Grdarasha&Ainkawa
Euphorbia spp L.	Euphorbiaceae	A. W	Broad leaf	Grdarasha
Lactuca serriola L.	Asteraceae	A.W. S	Broad leaf	Grdarasha&Ainkawa
Cardaria draba (L.)Desv.	Brassicaceae	A. W	Broad leaf	Grdarasha
Hordeum spontaneum	Poaceae	A. W	Narrow leaf	Grdarasha&Ainkawa
Lolium rigidum L.	Poaceae	A. W	Narrow leaf	Grdarasha&Ainkawa
Avena fatua	Poaceae	A. W	Narrow leaf	Grdarasha&Ainkawa
Centaurea iberica	Asteraceae	A. W	Broad Leaved	Ainkawa
Leontice leontopetalum L.	Berberidaceae	P. W	Broad leaf	Ainkawa

Note: A=Annual, B=biennial, P=Perennial, W=Winter, S=Summer

2.2 Agronomic practice

The fields were pre-irrigated on 9th November for softening land and after 10 days the fields of both locations were plowed with moldboard plow then clods were crushed and leveled by rotavator Bread wheat variety (Hawler-2) was received from Erbil Directorate of Agricultural Research/ Ainkawa. The seeds were sown on the 17th of December 2021 in lines directed east to west. Di-ammonium phosphate (D.A.P.) and the first dose of urea fertilizer were applied at the sowing date by (120 and 60 kg. ha^{-1}) respectively but the second dose of urea was added by (60 kg. ha^{-1}) before the flowering stage. Complementary irrigation has been done for both locations due to stop rainfall during flowering stage.

2.3 Spray application

In this experiment, two herbicides were used in combination, with three concentrations. the first one was ATLANTIS WG (3gm. kg^{-1} Mesosulfuron-methyl+ 6gm. kg^{-1} Iodosulfuron-methyl-sodium + 90gm. l^{-1} Mefenpyr–diethyl). The second herbicide was Infinity WG (granstar) Tribenuron-methyl is a selective and post-emergence herbicide (Essencechem, 2022).

The most effective to use with Atlantis WG is bioPower as adjuvant. The spraying was done on February 24, 2022, as a post-emergence when the wheat was at the tillering stage and the weed species had (3-4) real leaves. Battery Knapsack 20 L pressure sprayer with a T-jet nozzle was used, also calibration process was done to ensure the same dose for each plot and the spray volume was 460 L. ha^{-1} for all treatments.

2.4 Experimental Design and Data Analysis

The experiment was conducted using Randomized Complete Block Design (RCBD) in three replications at both locations. The plot size was 1.5 m x 2.6 m each plot consists of 13 wheat rows with 20 cm row spacing. Each plot and block were separated by 0.5 and 1.0 m paths, respectively. The experiment was consisting of two factors which are the following:

2.4.1 Weed control treatments

1- Weedy check (with weed) without herbicide spray. **(W.CH.)**
2- Weed-free (without weed or hand weeding) without herbicide spray. **(W.F.)**
3- Atlantis 240 gm. ha^{-1} + Granstar 35 gm. ha^{-1} (Herbicide Combinations Lower Doses) **(L.D.)**
4- Atlantis 320 gm. ha^{-1} + Granstar 50 gm. ha^{-1} (Herbicide Combinations Recommended Doses) **(R.D.)**
5- Atlantis 400gm. ha^{-1} + Granstar 65 gm. ha^{-1} (Herbicide Combinations Higher Doses) **(H.D.)**

2.4.2 Wheat seeding rates

1- 75 kg. ha^{-1} (First Seeding Rate) **(S.R.1)**
2- 100 kg. ha^{-1} (Second Seeding Rate) **(S.R.2)**
3- 125 kg. ha^{-1} (Third Seeding Rate) **(S.R.3)**

The data were subjected to standard analysis of variance and means were compared at a significant 5% level by Duncan test using SPSS version 25 computer analysis according to (Weinberg and Abramowitz, 2008, Field, 2009). As well as, (t-test) was done to detect the effect of locations combination.

2.5 Data Collection

2.5.1 Wheat traits

2.5.1.1 Flag Leaf Area (cm2)

Selected a mean of 10 flag leaves per plot at the main stem of bread wheat and then was calculated according to the following formula (Hunt, 1982).

$$\textit{Flag Leaf Area } (cm^2) = \textit{leaf length} \times \textit{leaf width} \times \textit{index factor } 0.905 \ldots\ldots \text{Equation 1}$$

2.5.1.2 Plant Height (cm)

plant height was measured for each treatment of wheat. The procedure was done during the physiological maturity of wheat at farm standing. The stem of ten plants was measured from soil surface to spike base of wheat and then calculated average height (cm).

2.5.1.3 Grain yield (ton. ha-1)

One square meter was harvested from each plot of wheat then threshed seeds and calculated in grams and transferred to ton per hectare.

2.5.1.4 Biological yield (ton. ha-1)

It was calculated by harvesting one square meter of matured wheat from each treatment from soil level and measured the whole plant in grams then transferred to ton per hectare.

2.5.2 Weed data

Weeds were cut from soil surface at random from one square meter from each plot after 105 days from sowing (Soliman et al., 2011).

2.5.2.1 Weed density (number of narrow and broad leaf weeds)

The pulled weed plants were classified and counted number of broad leaves, narrow leaves and total weed number.

2.5.2.2 Weed Dry Matter (g)

It was calculated for narrow leaf and broad leaf weeds after cutting and separating both categories. The classified weeds were dried in laboratory oven at 70˚C for 48 hours to a constant weight and dry matter of each part was weighted separately using sensitive electronics balance according (Netsere et al., 2012).

2.5.2.3 Weed Control Efficiency %

Weed control efficiency was calculated by adopting the following formula given by (Mani et al., 1973, Saraswat and Mishra, 1998) as follows:

$$WCE\% = \frac{(WDC - WDT)}{WDC} \times 100 \quad \text{..... Equation 2}$$

Where, WCE= Weed Control Efficiency; WDC=Weed dry matter in weedy check; and WDT= weed dry matter in a particular treatment.

2.5.2.4 Weed persistence index

This index demonstrates weed resistance to the tested treatments and confirms the efficacy of the selected herbicides. It was calculated using the formula provided by (Mishra et al., 2016).

$$WPI = \frac{DWT}{DWC} \times \frac{WCC}{WCT} \quad \text{..... Equation 3}$$

Where, DWT and DWC were dry weight of weeds in treated and weedy check (control) plots respectively, while WCC and WCT are weeds count in weedy check(control) and treated plot respectively.

3.Results

3.1 Effect of different herbicide combinations on some bread wheat parameters at Grdarasha and Ainkawa locations.

Table 4 shows that different herbicide combinations with varying concentrations had a significant effect on wheat flag leaf area (cm^2), plant height (cm), biological yield (ton. ha^{-1}) and grain yield (ton. ha^{-1}) at both studies locations. At Grdarasha, the highest flag leaf area (37.08 cm2) was observed in the weed free plot and the lowest (33.33 cm2) in the treated plot with (Herbicide Combinations Lower Doses) (L.D.), whereas at Ainkawa, the highest flag leaf area (35.05 cm2) and (34.61cm2) were observed in the weedy check and weed free plots, respectively. In addition, lowest flag leaf area (30.69cm^2) was observed in (Herbicide Combinations Lower Doses) (L.D.) plot. The data indicated the highest plant height (78.34cm) and followed by (78.12 cm) in weed free and (Herbicide Combinations Lower Doses) (L.D.) plots respectively and the lowest plant height (75.32 cm) in weedy check plot at Grdarasha location. However, in Ainkawa location highest plant height (73.16 cm) in weedy check and weed free plots followed by (72.82 cm) in (Herbicide Combinations Recommended Doses) (R.D.) plot. Also, lowest plant height (70.90cm) in (Herbicide Combinations Higher Doses) (H.D.) plot. As shown in table 4 total biomass yield significantly different between different herbicide treatments, the data showed highest (19.53) ton. ha^{-1} in (Herbicide Combinations Lower Doses) (L.D.) plot and lowest (13.90) ton. ha^{-1}in weedy check plot at Grdarasha location but for Ainkawa location the highest biological yield was recorded in Atlantis (Herbicide Combinations Higher Doses) (H.D.) and followed by (Herbicide Combinations Recommended Doses) (R.D.) which was (17.37) and (17.07) ton. ha^{-1} respectively in statistically parallel, and the lowest were observed in Weedy check, weed free and (L. D) which was statistically similar which were (16.16), (16.52) and (16.93) ton. ha^{-1} respectively. Grain yield similarly showed significant difference between treatment in both locations the highest grain yield (8.09) ton. ha^{-1} in (L. D) plot were recorded for Grdarasha location while highest 6.29 ton. ha^{-1} was recorded in (H. D) plot for Ainkawa location.

But lowest grain yield was (5.34) and (5.74) ton. ha^{-1} in weedy check plot for Grdarasha and Ainkawa location respectively.

3.2 Effect of different seeding rates on some bread wheat at Grdarasha and Ainkawa locations.

according to

Table *5* , different bread wheat seeding rates have a significant impact on flag leaf area, plant height, biological yield, and grain yield at both locations. At Grdarasha farm, seeding rate 125 kg. ha^{-1} plot showed highest flag leaf area (35.55cm^2) and statistically lowest flag leaf area (33.08cm^2) observed at 100 kg. ha^{-1}. However, at Ainkawa location statistically highest (33.98 cm^2) flag leaf area was observed at 75 kg. ha^{-1} seeding rate plot and lowest flag leaf area were obtained at 100 kg. ha^{-1} and 125 kg. ha^{-1} plots which was (32.67cm^2) and (33.14 cm^2) respectively. Moreover, plant height of wheat was significantly influenced by different seeding rates. As table 5 showed at Grdarasha location, the highest plant height (78.28cm) was observed in 125kg.ha^{-1} plot and statistically lowest plant height (76.11cm) and (77.46cm) were recorded in 75kg.ha^{-1} and 100kg.ha^{-1} respectively, Similarly at Ainkawa location the highest plant height (72.87cm) was observed in plots grown with Seeding rates 125kg.ha^{-1},and statistically lowest plant height(71.82cm) was recorded at 100kg.ha^{-1} plot. Furthermore, table 5 showed that the biological yield of wheat crop differed statistically between seeding rat treatments.At Grdarasha location highest (17.92) ton. ha^{-1} biological yield observed in 125kg.ha^{-1} seeding rate plot and lowest (16.74) ton. ha^{-1} biological yield recorded for 100kg.ha^{-1}. Contrary for Ainkawa location the highest (17.30) ton. ha^{-1} observed in 100kg.ha^{-1} seeding rate plot and lowest biological yield (16.13) ton. ha^{-1} observed in 75.kg. ha^{-1} seeding rate plot. As indicated in table 4 ,Grain yield of wheat significantly affected by seeding rates at both studied area.in Grdarasha location observed the highest (7.21)ton.ha^{-1} grain yield in plot with seeding rate 125kg.ha^{-1} and lowest (6.84) and (66.86)to.ha^{-1} in plots grown with seeding rates 100kg.ha^{-1} and 75kg.ha^{-1} respectively. In Ainkawa location highest 6.25 ton. ha^{-1} recoded for plots gown with seeding rate 100kg.ha^{-1} and lowest 5. 75ton.ha^{-1} was observed in 75kg.ha^{-1} seeding rate plot.

Table 4 Effect of different Herbicide combinations on bread wheat flag leaf area (cm^2), plant height (cm), biological yield (ton. ha^{-1}) and grain yield (ton. $^{-1}$) at Grdarasha and Ainkawa locations.

Herbicide combinations	Flag leaf area (cm^2)	Plant height (cm)	Biological yield (ton. ha^{-1})	Grain yield (ton. ha^{-1})
Grdarasha				
Weedy check	34.63 b	75.32 b	13.90 e	5.34 e
Weed free	37.08 a	78.34 a	17.98 c	7.40 c
Atla. 240 gm. ha^{-1} + Gran. 35 gm. ha^{-1} (L. D.)	33.33 c	78.12 a	19.53 a	8.09 a
Atla. 320 gm. ha^{-1} + Gran. 50 gm. ha^{-1} (R. D.)	34.55 b	77.26 ab	18.96 b	7.73 b
Atla. 400 gm. ha^{-1} + Gran. 65 gm. ha^{-1} (H. D.)	34.75 b	77.37 ab	16.28 d	6.29 d
Ainkawa				
Weedy check	35.05 a	73.16 a	16.16 b	5.74 e
Weed free	34.61 a	73.16 a	16.52 ab	6.09 c
Atla. 240 gm. ha^{-1} + Gran. 35 gm. ha^{-1} (L. D.)	30.69 d	71.87 b	16.93 ab	6.17 b
Atla. 320 gm. ha^{-1} + Gran. 50 gm. ha^{-1} (R. D.)	33.57 b	72.82 a	17.07 a	6.05 d
Atla. 400 gm. ha^{-1} + Gran. 65 gm. ha^{-1} (H. D.)	32.36 c	70.90 c	17.37 a	6.29 a

Note: different letters mean there was significant difference at 5% probability level by Duncan test. Where: L. D= lower dose, R. D=recommended dose, H. D=higher dose

Table 5 Effect of Seeding rates on flag leaf area, plant height, biological yield and grain yield of bread wheat at Grdarasha and Ainkawa locations.

Seeding Rates	Flag leaf area (cm^2)	Plant height (cm)	Biological yield (ton. ha^{-1})	Grain yield (ton. ha^{-1})
		Grdarasha		
75 kg. ha^{-1}	34.98 b	76.11 b	17.33 b	6.86 b
100 kg. ha^{-1}	34.08 c	77.46 ab	16.74 c	6.84 b
125 kg. ha^{-1}	35.55 a	78.28 a	17.92 a	7.21 a
		Ainkawa		
75 kg. ha^{-1}	33.97 a	72.45 a	16.13 b	5.75 c
100 kg. ha^{-1}	32.67 b	71.82 b	17.3 a	6.25 a
125 kg. ha^{-1}	33.14 b	72.87 a	16.99 a	6.21 b

Note: different letters mean there was significant difference at 5% probability level by Duncan test.

3.3. Effect of herbicide combinations on total weed number (m2), total weed weight, weed control efficiency % and weed persistence index.

The total weed number (m2) in both experimental wheat fields varied significantly between weed control treatments (table 6). As the (H. D) plot achieved the minimum average number of weeds, it reached (56.22) and (29.78) m^2 for Grdarasha and Ainkawa respectively, whereas, the comparison treatment (weedy check) plots gave the maximum average number (128.44) and (82.00) m^2 for Grdarasha and Ainkawa location respectively. More similarly the total weed weight(m^2) of studied experiment for both locations significantly influenced by different herbicide combination and concentrations. Table 6 shows that the lowest total weed concentrations were obtained in treatment (H. D), with values of (25.83) and (12.14) gm.m-2 for the Grdarasha and Ainkawa locations, respectively. While for compared treatment (weedy check) obtained highest total weed weight (412.02) and (122.52) $gm.m^{-2}$ for Grdarasha and Ainkawa location respectively. The highest weed control efficiency was obtained from (H. D) treatment which were (93.01%) and (90.15%) in Grdarasha and Ainkawa respectively. meanwhile statistically lowest weed control efficiency was observed in (R. D) plots which were (91.48 %) and (79.67%) for Grdarasha and Ainkawa location respectively. Weed persistence index indicating relative dry matter accumulation of weeds per count in comparison to control (Table 6) shows that the (H. D) treatment resulted in higher persistence index (0.16) indicating resistance of escaped weeds to control measures. Whereas, (R. D) showed lowest (0.14) in Grdarasha location. Contrary in Ainkawa location the highest weed persistence index was observed in (L. D) plot and lowest was in (H. D) plots, which were (0.51) and (0.27) respectively.

Table 6 Effect of herbicide combinations on total weed number (m^2), total weed weight, weed control efficiency % and weed persistence index

Herbicide combinations	Total weed number (m^2)	Total weed dry weight (gm. m^2)	Weed control efficiency%	Weed persistence index
	Grdarasha			
Weedy check	128.44 a	412.02 a	---	---
Weed free	__---__	__---_	_ ---___	__---___
Atla. 240 gm. ha^{-1} + Gran. 35 gm. ha^{-1} (L. D.)	62.89 c	27.52 c	91.90 b	0.15 b
Atla. 320 gm. ha^{-1} + Gran. 50 gm. ha^{-1} (R. D.)	79.00 b	33.42 b	91.48 c	0.14 b
Atla. 400 gm. ha^{-1} + Gran. 65 gm. ha^{-1} (H. D.)	56.22 d	25.83 c	93.01 a	0.16 a
	Ainkawa			
Weedy check	82.00 a	122.52 a	---	---
Weed free	__---___	__---___	__---___	__---___
Atla. 240 gm. ha^{-1} + Gran. 35 gm. ha^{-1} (L. D.)	33.55 c	24.35 b	80.69 b	0.51 a
Atla. 320 gm. ha^{-1} + Gran. 50 gm. ha^{-1} (R. D.)	42.11 b	25.40 b	79.67 c	0.41 b
Atla. 400 gm. ha^{-1} + Gran. 65 gm. ha^{-1} (H. D.)	29.78 d	12.14 c	90.15 a	0.27 c

Note: different letters mean there was significant difference at 5% probability level by Duncan test. Where: L. D. = lower dose, R. D. =recommended dose, H. D. =higher dose

3.4. Effect of seeding rates on total weed number (m^2), total weed weight (m^2), weed control efficiency % and weed persistence index.

Table 7 illustrates the effect of different seeding rates on total Weed Number (m^2), Total Weed Weight, Weed Control Efficiency % and Weed Persistence Index. the data showed that total weed number have significant difference between different seeding rates at both locations. The highest total weed number(m^2) was observed in plot grown with 75.kg. ha^{-1} seeding rate were (108.58) and (59.75) in Grdarasha field and Ainkawa field respectively. And lowest weed number(m^2) was achieved in plots grown with seeding rate 125 kg. ha^{-1} which were (58.92) and (34.17) in Grdarasha and Ainkawa location respectively. As same as total weed number(m^2) was significantly influenced by different seeding rates of wheat. The maximum total weed weight(m^2) was obtained in plot grown with 75.kg. ha^{-1} seeding rate were (174.21) and (56.84) in Grdarasha and Ainkawa location respectively. And minimum weed weight(m^2) was achieved in plots grown with seeding rate 125kg.ha^{-1} which were (66.61) and (39.61) in Grdarasha and Ainkawa location respectively.in addition table 7 showed that highest Weed Control Efficiency% was (94.43) observed in plot grown with 100kg.ha^{-1} and lowest(88.61) was observed in plot grown with 125kg.ha^{-1} for Grdarasha location .contrary in Ainkawa location highest (87.56) in plot grown with seeding rate 125kg.ha^{-1} and lowest(77.48) in plots grown with 75kg.ha^{-1} seeding rates were observed. Finally, in table 7 declared that highest (0.22) weed persistence index was recorded in plot grown with 125kg.ha^{-1} and lowest (0.11) weed persistence index in plot grown with seeding rate 100kg.ha^{-1} for Grdarasha location. While in Ainkawa location highest (0.62) was observed in (0.62) in plots grown with seeding rate 75.kg. ha^{-1} and statistically lowest (0.28) and (0.29) in plots 100kg.ha^{-1} and 125kg.ha^{-1} respectively.

Table 7 Effect of seeding rates on total weed number (m2), total weed weight (m2),weed control efficiency % and weed persistence index

Seeding rates	Total weed number (m^2)	Total weed dry weight (gm. m^2)	Weed control efficiency%	Weed persistence index
		Grdarasha		
75 kg. ha^{-1}	108.58 a	174.21 a	93.35 b	0.13 b
100 kg. ha^{-1}	77.42 b	133.28 b	94.43 a	0.11 c
125 kg. ha^{-1}	58.92 c	66.61 c	88.61 c	0.22 a
		Ainkawa		
75 kg. ha^{-1}	59.75 a	56.84 a	77.48 c	0.62 a
100 kg. ha^{-1}	46.67 b	41.86 b	85.47 b	0.28 b
125 kg. ha^{-1}	34.17 c	39.61 c	87.56 a	0.29 b

Note: different letters mean there was significant difference at 5% probability level by Duncan test.

3.5 Effect of different locations on some parameters of bread wheat.

Analyze of variance shows significant difference between two locations on flag leaf area, plant height and grain yield of wheat except of biological yield, which showed non-significant difference between two locations **Table 8**.

3.6 Effect of different locations on total weed number, total weed weight, weed control efficiency% and weed persistence index

Table 9 indicates significant difference of total weed number, weed control efficiency % and weed persistence index except total weed weight between Grdarasha and Ainkawa.

Table 8 Effect of locations on flag leaf area,plant height,biological yield and grain yield of bread wheat.

location	Flag leaf area(cm^2)	Plant height (cm)	Biological yield (ton. ha^{-1})	Grain yield (ton. ha^{-1})
Grdarasha	34.87*	77.28*	17.33	6.97*
Ainkawa	33.26	72.38	16.81	6.07
			N.S.	

Note: (*) means the value of parameters is significant, (N.S.) means the value of parameters is not significant.

Table 9 Effect of locations total weed number, total weed weight, weed control efficiency % and weed persistence index

location	Total weed number (m^2)	Total weed weight (m^2)	Weed control efficiency%	Weed persistence index
Grdarasha	81.64*	124.70	92.13*	0.15
Ainkawa	46.86	46.10	83.50	0.40*
		N. S		

Note: (*) means the value of parameters is significant, (N.S.) means the value of parameters is not significant

3.7 Interaction effects between herbicide combinations and seeding rates on flag leaf area (cm2) and plant height (cm) at Grdarasha and Ainkawa locations.

Figure 1: (A, B) represents the effect of two herbicide combinations with varying concentrations and seeding rates on wheat crop flag leaf area and plant height in Grdarasha and Ainkawa. Figure 1: A indicated highest flag leaf area (40.5) cm2 was observed in W. F.*S.R.3 plot and statistically lowest (30.7) and followed by (31.4) cm2 in plots L. D.*S.R.2 and W.CH*S.R.3 respectively for Grdarasha field. Plant height showed highest (79.2) cm2 in plot H. D.*S.R.3 and lowest (71.3) cm2 in plot W.CH.*S.R.3 for Grdarasha location. But for

Ainkawa location as showed in figure 1: B, the highest flag leaf area (37.6) cm^2 was observed in plot W.F.*S.R.3 and lowest (27.9) cm^2 was observed in plot L.D.*S.R.3. as well as, the highest (75.2) cm plant height was observed in W.F.*S.R.3 plot and lowest (69.9) cm in plot H.D.*S.R.3.

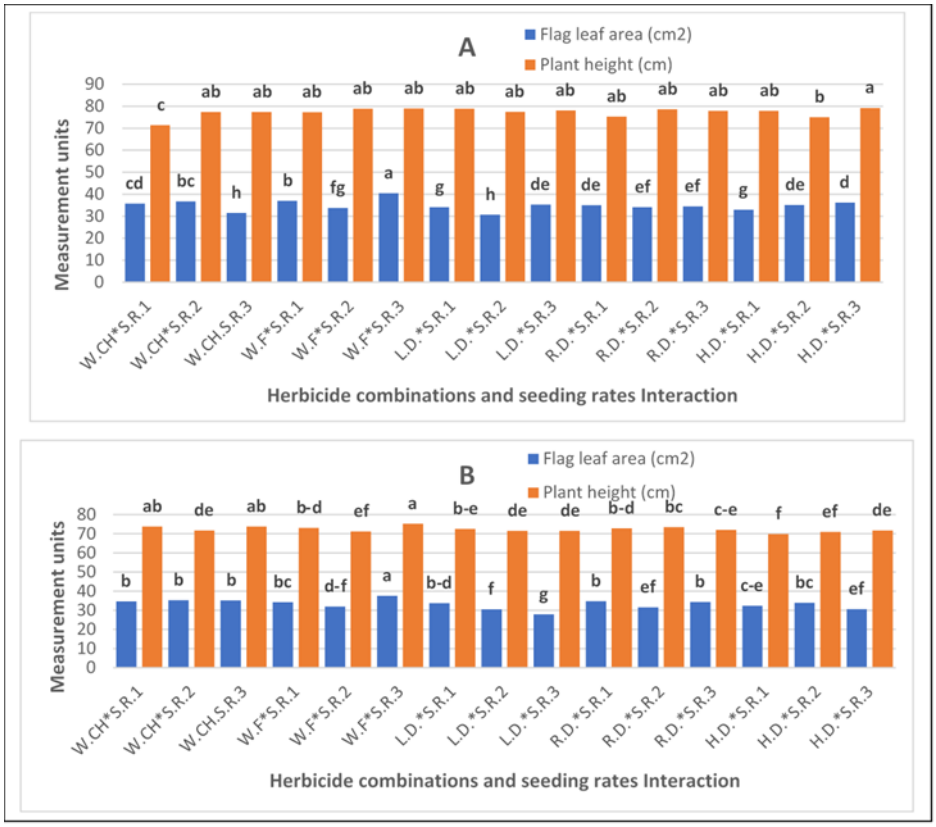

Figure 1(A,B) Interaction effects between herbicide combinations and seeding rates on flag leaf area (cm2) and plant height (cm) at Grdarasha(A) and Ainkawa (B). locations.

Note: different letters mean there was significant difference at 5% probability level by Duncan test. While: W. CH=weedy check, W. F=weed free, L. D= lower dose, R. D=recommended dose, H. D=higher dose, S. R.1= 75 kg. ha^{-1}, S. R.1= 100 kg. ha^{-1}, S. R.1= 125 kg. ha^{-1}

3.8 Interaction effects between herbicide combinations and seeding rates on biological yield (ton. ha^{-1}) and grain yield (ton. ha^{-1}) at Grdarasha and Ainkawa locations.

Figure 2: (A, B) indicate influence of two herbicide combination with different concentration and seeding rates on Biological Yield (ton. ha^{-1}) and Grain Yield (ton. ha^{-1}) at Grdarasha and Ainkawa location. Figure 2: A shows significant difference between different treatment, the maximum (21.5) ton. ha^{-1} biological yield was observed in plot (L. D.*S.R.3) and minimum (12.9) ton. ha^{-1} biological yield was observed in plot (W.CH.*S.R.1). similarly, the highest (8.83) ton. ha^{-1} grain yield was observed in plot (L. D*S.R.3) and lowest (3.9) ton. ha^{-1} grain yield was observed in plot (W.CH.*S.R.1). For Ainkawa location as showed in figure 2: B the maximum (18.5) ton. ha^{-1} biological yield was observed in plot (R.D.*S.R.2) and minimum (15) ton. ha^{-1} biological yield was observed in plot (W.CH.*S.R.1). And the highest (6.88) ton. ha^{-1} grain yield was observed in plot (W.F.*S.R.3) and lowest (5.19) ton. ha^{-1} grain yield was observed in plot (W.CH.*S.R.1).

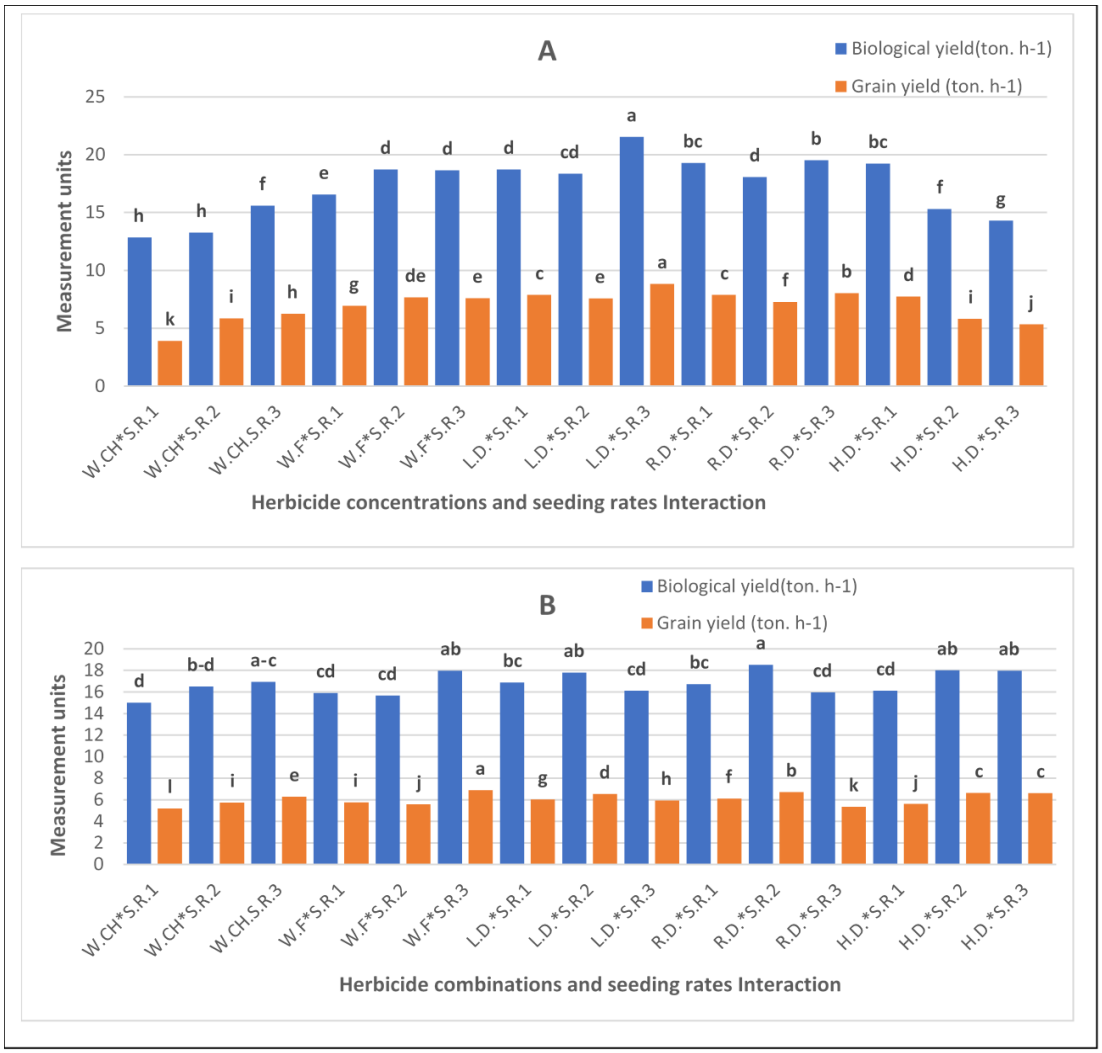

Figure 2:(A,B) Interaction effects between herbicide combinations and seeding rates on biological yield (ton. ha^{-1}) and grain yield (ton. ha-1) at Grdarasha(A) and Ainkawa(B) location.

Note: different letters mean there was significant difference at 5% probability level by Duncan test. While: W. CH.= weedy check, W. F.=weed free, L. D.= lower dose, R. D.=recommended dose, H. D.=higher dose, S. R.1= 75 kg. ha^{-1}, S. R.1= 100 kg. ha^{-1}, S. R.1= 125 kg. ha^{-1}

3.9 Interaction effects between herbicide combinations and seeding rates on total weed number (m2) and total weed weight (m2) at Grdarasha and Ainkawa locations.

figure 3: A indicates significant variation between different treatments for Grdarasha location, maximum total weed number and total weed weight were observed in plot W.CH.*S.R.1 which were (175) and (580. 87gm.m^{-2}) respectively, while observed minimum (38.67) and (19. 27gm.m^{-2}) respectively for plot H.D.*S.R.3. similarly, for Ainkawa location as showed figure 3: B, observed that maximum total weed number and total weed weight were observed in plot W.CH.*S.R.1 which were (114) and (135. 7gm.m^{-2}) respectively. Besides lowest (26) and (9. 1gm.m^{-2}) were observed in plot H.D.*S.R.3 for total weed number and total weed weight, respectively.

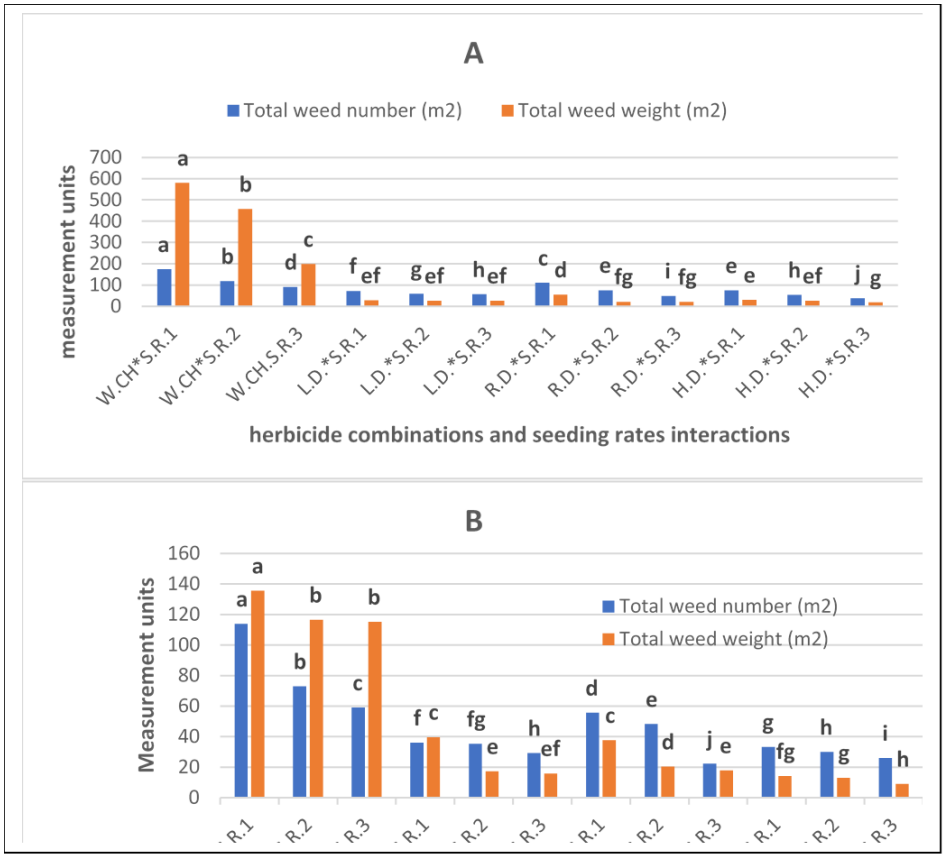

Figure 3: A, B Interaction effects between herbicide combinations and seeding rates on total weed number (m^2) and total weed weight (m^2) at Grdarasha(A) and Ainkawa(B) locations.

Note: different letters mean there was significant difference at 5% probability level by Duncan test. While: W. CH.=weedy check, L. D.= lower dose, R. D.=recommended dose, H. D.=higher dose, S. R.1= 75 kg. ha^{-1}, S. R.1= 100 kg. ha^{-1}, S. R.1= 125 kg. ha^{-1}.

3.10 Interaction effects between herbicide combinations and seeding rates on weed control efficiency % at Grdarasha and Ainkawa locations.

figure 4: A indicates that highest (95.11) weed control efficiency% was observed in plot L.D*S.R.1 and lowest (86.56) weed control efficiency was observed in plot (L.D.*S.R.3) for Grdarasha location. While highest (92.12) weed control, efficiency % was obtained in plot H.D.*S.R.3 and lowest (70.71) recorded in plot (L.D.*S.R.1) as shown in figure 4: B for Ainkawa location.

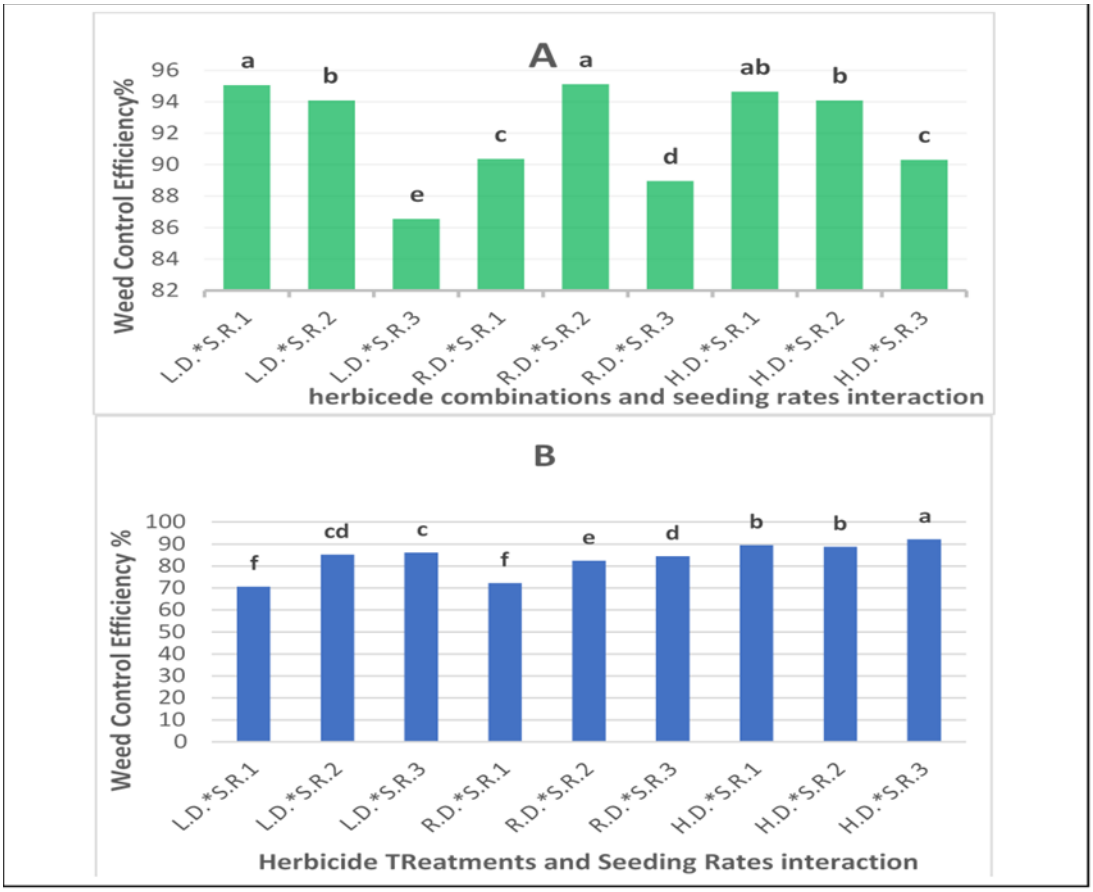

Figure 4: A, B Interaction effects between two herbicide combinations and seeding rates on weed control efficiency % at Grdarasha(A) and Ainkawa(B) locations.

Note: different letters mean there was significant difference at 5% probability level by Duncan test. While: L. D.= lower dose, R. D.=recommended dose, H. D.=higher dose, S. R.1= 75 kg. ha^{-1}, S. R.1= 100 kg. ha^{-1}, S. R.1= 125 kg. ha^{-1}.

3.11 Interaction between herbicide combinations and seeding rates on weed persistence index at Grdarasha and Ainkawa locations.

Figure 5: A shows that highest (0.23) weed persistence index was observed in plot H.D.*S.R.3 and lowest (0.08) observed in plot R.D.*S.R.3 for Grdarasha location. In contrast, for Ainkawa location as showed in figure 5: B the maximum (0.93) weed persistence index was observed in plot L.D.*S.R.1 and minimum (0.18) observed in plot H.D.*S.R.3for Ainkawa location.

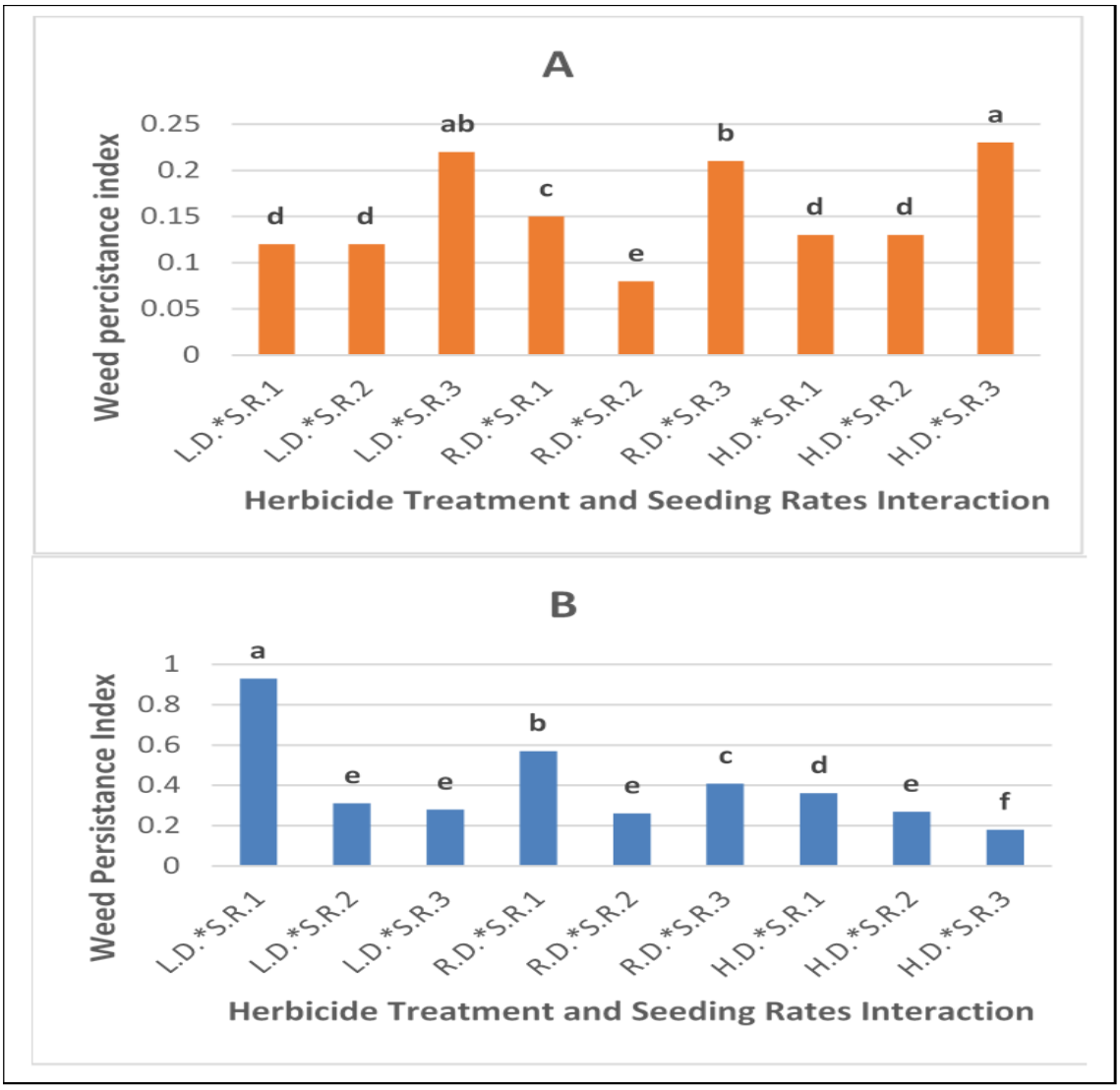

Figure 5: A,B interaction effects between herbicide combinations and seeding rates on weed persistence index at Grdarasha(A) and Ainkawa(B) locations.

Note: different letters mean there was significant difference at 5% probability level by Duncan test. While: L. D.= lower dose, R. D.=recommended dose, H. D.=higher dose, S. R.1= 75 kg. ha^{-1}, S. R.1= 100 kg. ha^{-1}, S. R.1= 125 kg. ha^{-1}.

4. Discussion

The current research results showed that flag leaf area of wheat significantly affected by herbicide combination and seeding rates of wheat. Flag leaf area was highest in weedy free and weedy check plots compared with herbicide combinations with different concentrations. Flag leaf area turn to smaller with increasing herbicide concentrations. This result was in agreement with findings of (Misbahullah and Khalil, 2019, Naby and Ali, 2020b). As well as seeding rates have significant influence on flag leaf area of wheat, flag leaf area reduced with increasing seeding rates this is will due to increasing wheat population, same findings were observed by (Akol et al., 2021) as they showed (180 $kg{\cdot}ha^{-1}$) of wheat gave the maximum value of the flag leaf area in both growing seasons (40.84 and 39.95 cm^2) compared with the (300 $kg{\cdot}ha^{-1}$) that gave the lowest values (30.20 and 29.31 cm^2) in both growing seasons, respectively. As well as plant height significantly influenced by different weed control treatments. The results showed that highest plant height was observed in weedy free plots and followed by Atlantis (240 gm. ha-1) + Granstar 35 g. ha^{-1} This could be because the

herbicides contains components that cause the plant cells to elongate, the results was agreed with findings of Al-Khafji et al. (2020) indicated that the addition of herbicides had a clear effect on increasing the plant height, as Atlantis WG + BioPower SL achieved the maximum average height of (107.5 cm). Atnafu et al. (2019) Illustrated that the highest plant height was achieved from weed free plots (124.3cm) followed by Clodinafop-propargyl at 1.5 L ha-1 + Tribenuron-methyl at 15g ha-1 (123cm) whereas; the lowest was recorded weedy check plots (77.8cm) .furthermore the seeding rates showed significant impact on wheat plant height . plant height increased with increasing seeding rates; this is due to increasing plant density. This results agreed with findings of Baloch et al. (2010) as they showed highest of wheat plant increase with increasing seeding rate , as they observed (84.4), (86.6) and (89.9) cm for seeding rates 100, 125, and 150 kg.h^{-1} respectively.

In addition, the yield attribute traits of wheat were significantly influenced with different weed control approaches. The research results showed that biological yield and grain yield significantly increased with conducting different weed control methods compared with weedy check plots, relatively same results were observed by (Belete et al., 2018) who revealed that weed management showed significance differences on total above ground biomass yield that recorded highest value (11.99) ton. ha^{-1} at the plot of weed free and the lowest value 5.43ton. ha^{-1} at weedy check plots. Grain yield was significantly varied due to weed management method where the highest grain yield of 4.78ton. ha^{-1} was recorded from the weed free treatment and the lowest of 1.30 ton. ha^{-1} was recorded from the treatment of weedy plots. Similarly Al-Wagaa and Mohammed (2020) as well showed that there was a significant change between the weed control treatments. As the weedy check plot gave the minimum yield reached 4.85 ton.ha^{-1}compared with rest of control treatments that attained a yield of (6.10), (5.82), (5.60) and (5.40) tons.ha^{-1} for each of Atlantis WG+ BioPower SL, Atlantis WG, CLODEX 100EC +SPOTLIGHT WDG 75 and CLODEX 100EC +SPOTLIGHT WDG 75, respectively. Rehmani et al. (2021) exposed that seed rate of 150 kg ha^{-1} with row spacing of 20 cm were more effective in influencing the yield and yield contributing traits i.e. biological yield and grain yield as compared to 125 kg ha^{-1} with any row spacing. As observed highest (11.64) and (4.43) ton. ha^{-1} in seeding rate 150kg.ha^{-1}for biological and grain yield respectively.

The results of research showed that total weed number and total weed dry weight (g.m^{-2}) was significantly varied with weed control methods compared to weedy check plots in both studied locations. Total weed number and total weed dry weight showed peak results for weedy check plots. while results decreased with apply different herbicide concentrations, seeding rates and interaction between them. This indicated that apply any weed control technique at appropriate time and rates give good result for decreasing weed number and dry weight of weeds in wheat farm, in turn give better growth and yield for grown crop. Similarly (Elattar and Moustafa, 2021) founded that highest weed dry weight was observed at two growing seasons, as showed highest for weedy check plots (2792.2) and (2646.2) gm.m^{-2} at 2018 and 2019 respectively and Atlantis herbicide showed 70.55 and 47.33 gm.m^{-2} for both seasons respectively. In addition (Daba and Mekonnen, 2022) observed in rice field that highest weed dry weight for weedy check plots was achieved (774.33),(510) and (341.67) in (30) cm 25 and 20 cm row distances respectively, and dry weight of weeds was decreased with apply different weed control methods as well as Horamani et al. (2022) emphasized that weed dry weight was reduced with apply mixture herbicides, as founded that highest value (373.46) and (342.33)gm.m^{-2} weed dry weight were observed in weedy check plots for Qlyasan and Kanipanka location respectively, while lowest records were (68.15) and (51.45) gm.m^{-2} for both locations respectively in plots treated with herbicide combinations (Topic+Granstar) which they kill narrow leaved weeds and broad leaved weeds .

Weed control efficiency % showed significant difference between different herbicide concentrations and seeding rats. Weed control efficiency % was rose by increasing herbicide concentrations and seeding rates this results in line with findings of Damtew (2018) .The higher weed control efficiency with these treatments could be attributed to the lower weed population as well as dry matter accumulation of weeds in these treatments. As well as (Elattar and Moustafa, 2021) was showed that highest weed control

efficiency% was observed for atlantis herbicide (97.5%) and (98.2%) for 2018 and 2019 season respectively while followed by pallas herbicide (96.3%) and (96.5) for both seasons respectively. In addition (Daba and Mekonnen, 2022) indicated that higher plant population showed higher weed control efficiency% as showed (76.89%) and (74.77%) for 20 and 30 cm row spacing respectively. Weed persistence index indicating relative dry matter accumulation of weeds per count in comparison to control results of research showed that the Atlantis (400gm. ha-1) + Granstar 65 g. ha^{-1} resulted in higher persistence index whereas, Atlantis (320gm. ha-1) + Granstar 50 g. ha-1 showed lowest ,the results was agreed with findings of (Mishra et al., 2016) indicated that the hand weeding plot obtained in higher persistence index (3.59), whereas, fenoxaprop + (chororimuron + metsulfuron) (1.54) and cyhalofop-butyl + (chlorimuron + metsulfuron) (1.89) have recorded lower persistence of escaped weeds indicating broad spectrum effect in controlling the weeds. Finally, the effect of locations showed significant impact between both locations for all parameters except of biological yield and total weed weight.

5. Conclusion:

Herbicide combinations and seeding rates used in this study significantly affected the growth and yield of wheat and its associated weeds. Decreasing concentration of herbicide combinations and increasing seeding rates have increased yield of wheat. Whereas, increasing herbicide combinations concentration and increasing seeding rates reduced weed total number and weight. Hence, this combination can be use in controlling weeds in wheat more efficiently and successfully reducing reliance on one herbicide alone.

Conflict of Interest

The authors declare no conflict of interest.

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