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Physiological and Yield Responses of Wheat (Triticum aestivum) to Different Herbicide Treatments

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Abstract

A field study was conducted at Erbil agricultural research directorate to investigate the physiological and yield responses of wheat to five post emergence herbicides; Tribenuron-methyl; Pyroxsulam; mesosulfuron+ idosulfuron; Clodinafop-propargyl and Clodinafop-propargyl +Pinoxaden herbicides, while weed infested wheat plots and weed free wheat plots treated as controls. Results revealed significant increase of plant height when treated with Clodinafop-propargyl herbicide comparing to the lowest height in weed-free wheat plots. Number of spikes per meter square significantly increased with Pyroxsulam and reduced in weed infested wheat plots. Number of grains per spike and 1000 grains weight were at maximum levels in weed-free wheat plots and minimum levels were found with weed infested wheat treatments. Biological yield significantly increased with Clodinafop-propargyl herbicide, while Tribenuron-methyl caused a significant decrease of biological yield. All treatments caused a significant increase of economical yield compared with weed infested wheat plots. Chlorophyll content reduced in wheat plants after spraying herbicides showed sever reduction after spraying all studied herbicides with recovery process of photosynthetic pigments except with Pyroxsulam and mesosulfuron+ idosulfuron herbicides. According to EWRC scale the most efficient to less efficient herbicide arrangement will be as Clodinafop-propargyl +Pinoxaden, mesosulfuron+ idosulfuron, Pyroxsulam, Clodinafop-propargyland Tribenuron-methyl.

Introduction

Wheat represents the largest acreage crop in Iraqi Kurdistan Region, covers about 78% of rain-fed area [1], meanwhile weed plants which aredefined as plants out of place and considered as the main biotic stress that influences wheat crops directly, when reduced yield and indirectly, when the impact prolong to post-harvest conditions [2]. Weed and crop relationship (Interference) consists of competition and allelopathy, the first concept involve competing for growth resources, while the second concept reveled to the exudation of chemical compounds (allelochemicals) that restrict or induce the growth of plants in the vicinity [3] and [4]. [5] Argue that weed problems are getting worst in future because of economic expenses of weed control; the elevating herbicidal prices; higher yields demanding; economic and political factors. Immoral herbicide use by farmers causes serious damaging not only to the crop but even to the agro-environment. Miss-use of herbicides, increasing herbicide resistance weed plants and soil and irrigation water contamination eventually causes killing of non-target organisms which might alter the natural balance of the area [6], [7] and [8]. It is well known that there is a great demand on compounds with selective toxicity, safe for environment without affecting treated crop plants and don't have any poisonous residual derbies [9], [10] and [11].[12] reported that post emergence herbicides increased yield and reduced weed density with significant effects of Coldinafop-propagyl on weed control when compared to Pyroxsulam when used alone.

It was concluded that adding adjuvants such as Arkopal N100(phenol polyglycol ether) in different doses to both herbicides (Coldinafop-propagyl) and (Clodinafop-propargyl 2.5% - Pinoxaden2.5%) caused significant reduction in weed plants dry weight, total number of weed plants, photosynthetic pigments of wheat plants, elevating yield and yield components of wheat, levels of protein, phosphorus and potassium elements when compared with un-weeded treatments [13]. [14] used the European weed research council scale (EWRC) for ocular evaluation of used herbicides for estimating the effect of some herbicides concluded ten herbicides, four dual purpose herbicides and six narrow leaf herbicides, it was approved that the impact of Coldinafop-propagylto narrow leaf was higher when compared with tribbenuron- methylto broad leaf when used on wheat due to the invasive characteristics of grass weeds in the area of study, with reporting retardant effect on photosynthetic pigments of the wheat plants [15]. Comparing two different herbicides for weed control in different wheat cultivars it was reported that tribbenuron- methyl impact on weed density was significantly higher than coldinafop- propagyl in central region of Iraq [16].[17]approved that weed density was significantly reduced when wheat field was sprayed with coldinafop- propagyl after trisulfuron which is pre-emergence herbicide comparing to using both herbicides tribbenuron- methyl and coldinafop- propagyl when tank-mixed. The aim of this study was to evaluate the effect of Granstar (tribbenuron- methyl), Pallas (Pyroxsulam 4.2%), Atlantis (mesosulfuron+ idosulfuron 30g.L^{-1}), Topic (clodinafop-propargyl 240Ec) and new introduced herbicide to the area Traxose (clodinafop-propargyl2.5% - Pinoxaden2.5%) herbicides on the physiological traits, growth and yield of wheat plants comparing to both wheat treatments with and without weed plants.

Materials & Methods

1) Study Site: the experiment was conducted on the fields of Erbil directorate research center during 2012-2013 growing season. The soil structure was silt clay with pH 7.85, organic matter 1.13% and Electrical conductivity 0.35dS.m^{-1}. Metrologicaldata was recorded by the automated meteorological station in the field during the period of the study (Table-1).

Table (1): Some meteorological data of Ainkawa location during 2012-2013 agricultural season.

Year/Month		Temperature			Precipitation	Humidity	Soil Temp. (C°)
		Min.	Max.	Average	(mm)	Average	30cm
	October	17.3	30.2	23.7	14.7	52.2	27.5
2012	November	10.9	20.5	15.7	52.3	71.3	19.7
	December	5.1	13.6	9.3	89.9	79.1	12.3
	January	2.3	11.9	7.1	169	82	8.9
	February	5.8	16.1	10.9	59.2	82.8	11.3
	March	7.2	19.5	13.4	20.5	68.9	14.2
2013	April	11.1	25.8	18.4	30.8	65.5	19.6
	May	15.7	30.9	23.3	52	59.9	25.6
	June	22.9	38.4	30.7	0	38.8	32.2
	July	25.6	42.8	34.2	0	34.5	36
	Total				488		

2) Experimental design: the experiment consisted of seven treatments; Weed-Free wheat (zero weed); non-sprayed wheat (weed-infested); five other plots were wheat sprayed with **Granstar®** (tribbenuron-methyl); **Pallas®** (Pyroxsulam 4.2%); **Atlantis®** (mesosulfuron+ idosulfuron30g.L^{-1}); **Topic®** (clodinafop-propargyl 240Ec) and **Traxose®** (clodinafop-propargyl2.5% + Pinoxaden2.5%). Treatments were laid out in a completely randomized block design with three replicates and plot size (2×3 m) each consisting 10 rows.

3) Agronomical practices: experimental plots were prepared by two dry plowings, land leveling, plowing by rotavator, then rows were established by chisel plow after that it was hand seeded with soft (bread) wheat ***Triticum aestivum***Rizgari cultivar on 15/ 11 /2012with the rate of 100kg.ha^{-1} keeping 20cm apart (**between rows**). Weed seeds were sown at the same timeof cultivationwith the density of 6 seeds of each studied species wild oat ***Avenafatua***; rigid rye grass ***Loliumrigidum***; and dicots or broad leaf weeds such as wild mustard ***Brassica nigra***, and syrianchephalaria***Cephalariasyriaca*** per one meter field, fertilizers

were used as DAP (Diammonium phosphate) with the rate of 100 kg.ha^{-1} with sowing process and followed by Urea fertilizer after 60 days from sowing with the rate of 80 kg.ha^{-1}.

4) Herbicide Application: post emergence herbicides used were Granstar (tribenuron- methyl) for broad leaf weeds with the rate of 20g.ha^{-1}; Pallas (Pyroxsulam 4.2%) and Atlantis (mesosulfuron+ idosulfuron 30g.L^{-1}) both are dual purpose with the rate of 308.9ml.ha^{-1} and 1.5L.ha^{-1} respectively; Topic (clodinafop-propargyl 240Ec) and Traxose (clodinafop-propargyl2.5% - Pinoxaden2.5%) for narrow leaf weeds with the rate of 1.2 L.ha^{-1}and 1.5l.ha^{-1} respectively. Spraying process carried out at 3/3/2013 when the wheat plants were at tillering stage. knapsack sprayers Matabi 16L type with Teejet nozzle were used each for one herbicide after calibration process for insuring that the treated dose for each plot is the same, both control plots were sprayed with water.

5) Data Recording: wheat photosynthetic pigments such as total chlorophyll were estimated one hour before spray and after 2, 4, 6, 8, 12 days from spraying by using Minolta chlorophyll meter spad-502 [18]. other parameters were wheat Plant Height (cm); spikes per meter square; spikelet's per spike; seeds per spike, 1000 seeds weight (g) biological yield (ton.ha^{-1}); economical yield (ton.ha^{-1}) and harvest index. Yield reduction was estimated according to the equation below

$$\text{Yield Reduction } \% = \frac{W0 - Ws}{W0} \times 100 \qquad \ldots\ldots\ldots (1)$$

Where W0 is the yield in (weed-free) zero weed plots and WS is the yield in different studied plots, which include all other investigated factors [19], [20] and [21].

6) Statistical analysis: all recorded data were subjected to standard analysis of variance and means were compared using Duncan Multiple Range Test (DMRT) at 5% of probability using SPSS computer analysis according to [22] and [23].

Results & Discussion

Results in table 2 indicated significant effects P≥0.05 of post emergence herbicides on plant height, where the maximum height (91.07cm) was observed with Topic herbicide, while the minimum (81.73cm) was with (Zero weed) wheat plots. These results are in accordance with [12] and [24] who resumed that the effect may be due to cell enlargement stimulation by clodinafop-propargyl herbicide to wheat plants [25]. Number of spikes per meter square increased significantly from lowest value (205 spikes m^{-2}) in weedy wheat plots (No herbicides) to the highest (269 spike m^{-2}) when plots where treated with pyroxsulam. These results were in harmony with [15] and [26] who reported that herbicides increases crop plants ability of utilizing environmental resources for increasing spikes per meter square with higher impact of broad weed herbicides which control both narrow and broad leaf weeds [27].

Table-2: The effect of post Emergence Herbicides on Some Traits of Wheat *Triticum eastivum*

Treatment	Plant Length (cm)	Number of Spikes per meter square (Spike*m^{-2})	Number of Grains per Spike (Grain*spike^{-1})	1000 Kernel Weight (g)
Granstar	86.07^{ab}	215.33^{d}	36.63^{d}	37.62^{c}
Pallas	88.30^{a}	269.67^{ab}	44.37^{c}	36.85^{c}
Topic	91.07^{a}	244.33^{bc}	45.77^{c}	37.35^{c}
Atlants	80.00^{c}	262.67^{ab}	42.83^{c}	40.80^{b}
Traxose	85.87^{ab}	240.00^{c}	51.90^{b}	41.72^{b}
pure wheat (zero Weed)	81.73^{bc}	239.00^{c}	56.23^{a}	44.84^{a}
Wheat & weed	89.40^{a}	205.00^{d}	33.57^{d}	35.57^{c}

Within each character, values sharing similar alphabetical letters are not significant at (5%).

Using post emergence herbicides in this study caused significant increase in grain numbers per spike where

the highest (56.23 grains. spike^{-1}) was recorded with Zero weed wheat plots. Meanwhile lowest (33.57 grains. spike^{-1})was when no herbicides were applied to weedy wheat plots, these results were conformable to what have been reported by [28] and [15] who indicated that it may be due to absence of interference which consists of competition and allelopathy between weed and wheat crop plants in zero weed plots [16]. Similar records were observed with weight of thousand kernels when the highest data 44.84 g was with Zero weed wheat plots no herbicide application compared with lowest data (35.57g) with weedy wheat plots with no herbicide application. Supporting view was reported by [10] and [29] who indicated the importance of absence of competition during early crop plant growth to improve its quality.

Figure (1) elucidated that post emergence herbicides caused significant increase in wheat biological yield whereas the highest value (16.67 ton. ha^{-1}) was when clodinafop-propargyl herbicide was used comparing to lowest data (11.80 ton. ha^{-1}) when tribenuron- methyl herbicide used. Previous results were in agreement with what have been indicated by [17] who assumed that the reason could be due to the mode of action of used herbicide that eliminate competition between grass weeds [3]. Economical yield was significantly affected when post emergence herbicides were used, whereas the highest level (6.02 ton. ha^{-1}) was in weed free wheat plots (zero weed) while the lowest value (2.45 ton. ha^{-1}) was recorded in weedy wheat plots, these findings were in accordance with [30] and [10] who conformed the importance of competition process at early wheat growth stages.

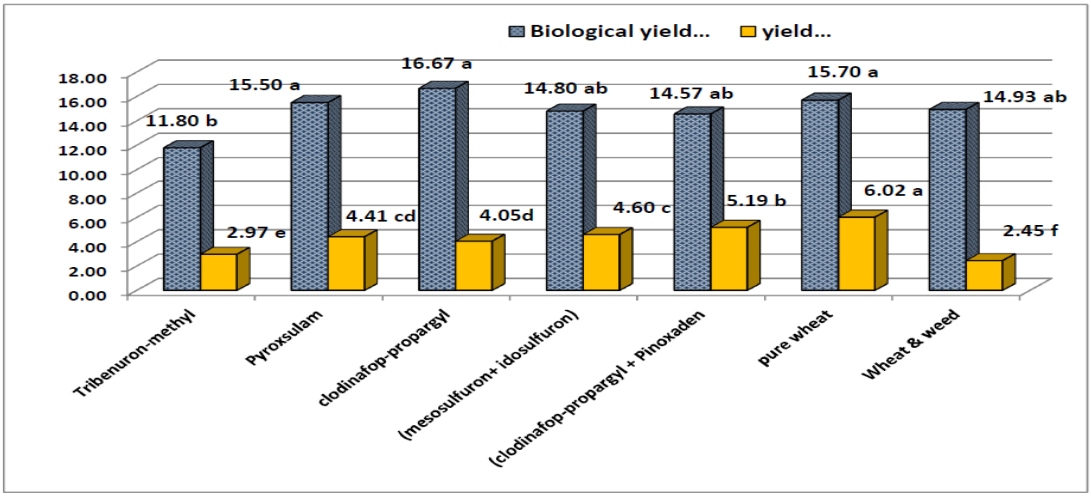

Figure 1: The effect of post emergence herbicides on Biological and economical yield of wheat (Ton.Ha^{-1})

Similarly data concerning harvest index (Figure-2) indicated significant effect of herbicides when compared to weedy wheat plots (0.16) and the highest index (0.39) with pure wheat plots, results here were in concord with [25] who reported that harvest index was proportional with grain yield due efficient use of growth resources [31].

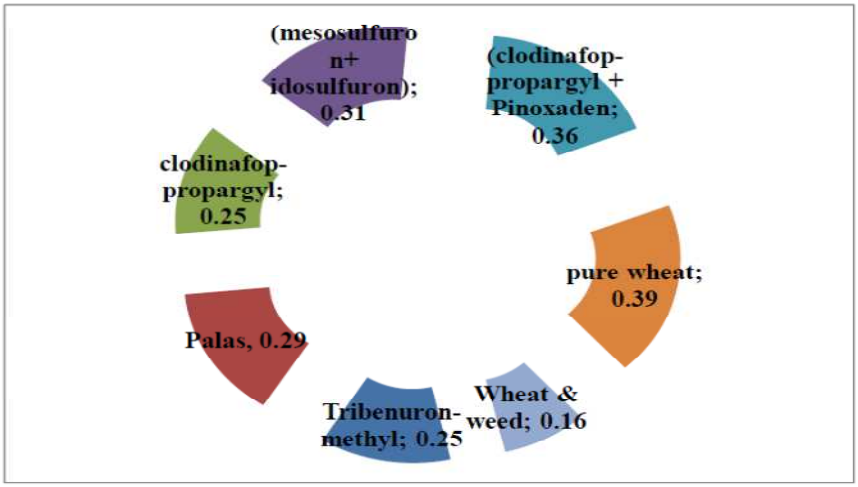

Figure 2: The effect of post emergence herbicides on Harvest Index of wheat

Data in (Table-3) indicated significant differences between chlorophyll content after spraying post emergence herbicides, it was obvious that sever reduction in chlorophyll levels starts 2 days after spraying with clodinafop-propargyl herbicide comparing to other tested herbicides. Chlorophyll results were in agreement with [32] and [33] who indicated that some herbicides cause photo-peroxidation of thylakoid, which are susceptible to lipid peroxidation and other cell membrane lipids.

Table-3: The effect of post emergence herbicides on Total chlorophyll of wheat (SPAD)

Herbicides	0 day	2 Days	4 Days	6 Days	8 Days	12 Days
Granstar	38.36^{a}	38.33^{ab}	36.97^{ab}	36.50^{b}	40.90^{ab}	41.23^{ab}
Pallas	38.86^{a}	36.67^{bc}	34.50^{b}	34.37^{b}	36.70^{bc}	36.36^{c}
Topic	39.16^{a}	34.90^{c}	34.10^{b}	35.27^{b}	35.83^{c}	40.33^{abc}
Atlants	38.96^{a}	39.50^{a}	35.37^{a}	35.87^{b}	37.10^{abc}	37.56^{bc}
Traxose	39.56^{a}	39.20^{a}	36.27^{ab}	37.07^{ab}	39.07^{abc}	42.46^{a}
pure wheat	38.18^{a}	38.43^{ab}	39.70^{a}	40.40^{a}	41.70^{a}	44.07^{a}
Wheat & weed	38.46^{a}	38.47ab	39.27^{a}	40.10^{a}	35.73^{c}	42.46^{a}

Within each character, values sharing similar alphabetical letters are not significant at (5%).

Interference between crop plants and weeds at early stages decreases yield of crop plants and this was clearly demonstrated in this study according to yield reduction equation as a result of application of post emergence herbicides comparing to (Zero weed) wheat plots. where there were significant differences and the highest reduction percentage (59.34) was with weedy wheat plots, these outputs were in harmony with (Milberg and Hallgren., 2004) and (El-Rokiek*et al*., 2012) who indicated the reason as weed and wheat competition plus the retardant effect of herbicides as a result of reduction in chlorophyll content of wheat plant leaves (Figure3)

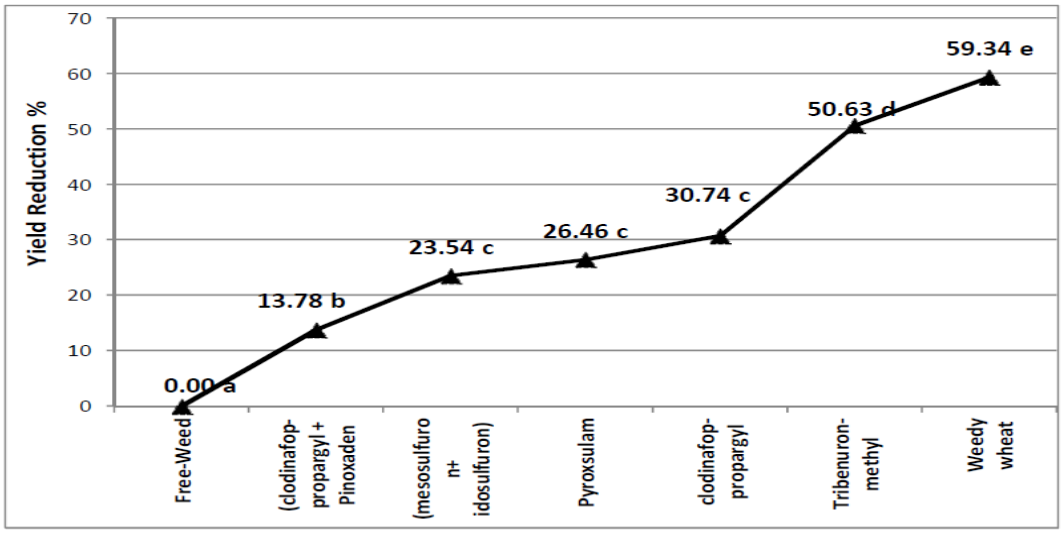

Figure 3: The effect of post emergence herbicides on Yield reduction Percentage

Conclusion

All post emergence herbicides used in this study, caused negative impact on wheat growth and yield components when compared with weed-free wheat plots, while it elevates the yield of wheat comparing to weed-infested wheat control plots. According to European Weed Research Council (EWRC), yield reduction

equation for all studied post emergence herbicides could be arranged from the highest to the lowest efficient herbicide in the study as Traxose, Atlants, Pallas, Topic and Granstar.

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