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Effect of herbicides and irrigation levels on growth and yield of barley (*Hordeum vulgare* L.) var. Ratna

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Abstract
A field experiment was carried out of find out the "Effect of herbicides and Irrigation levels on growth and yield of barley. At the crop research center of Brahman and post graduate College Rath Hamirpur U.P during the Rabi season of 2020-21. The experiment comprises of twelve treatments, T_1 - (No herbicides) Control + (No irrigation) control T_2 - (No herbicides) Control + One Irrigations on CRI at 25 DAY stage, T_3 - (No herbicides) Control+ Two Irrigations at 25 Day CRI, 2nd at 55 Day flowering, T_4 - (No herbicides) Control + Three Irrigations 1st at 25 Day CRI, 2nd at 55 Day flowering and 3rd at 85 Day drought stages, T_5 – Pendimethalin @ 1.5 lit/ha+ No irrigation) control, T_6 – Pendimethalin @ 1.5 lit/ha + One Irrigations on CRI at 25 Day stage, T_7 – Pendimethalin @ 1.5 lit/ha+ Two Irrigations at 25 Day CRI, 2nd at 55 Day flowering, T_8 - Pendimethalin @ 1.5 lit/ha+ Three Irrigations 1st at 25 Day CRI, 2nd at 55 Day flowering and 3rd at 85 Day drought stages, T_9 - 24 D sodium salt 80 @ 75 kg/ha + (No irrigation) control, T_{10} - 24 D sodium salt 80 @ .75 kg/ha + One Irrigations on CRI at 25 Day stage, T_{11} - 24 D sodium salt 80 @ 75 kg/ha+ Two Irrigations at 25 Day CRI, 2nd at 55 Day flowering, T_{12} -24 D sodium salt 80 @ 75 kg/ha+ Three Irrigations 1st at 25 Day CRI, 2nd at 55 Day flowering and 3rd at 85 Day drought stages, T13-Sulfosulfuron @75 wp 1.lit/ha +(No irrigation) control, T_{14} - Sulfosulfuron @75 wp 1.lit/ha Control + One Irrigations on CRI at 25 Day stage, T_{15} - Sulfosulfuron @ 75 wp 1.lit/ha+ Two Irrigations at 25 Day CRI, 2nd at 55 Day flowering, T_{16} - Sulfosulfuron @ 75 wp 1.lit/ha++ Three Irrigations 1st at 25 Day CRI, 2nd at 55 Day flowering and 3rd at 85 Day drought stages, Were tested in Randomized block design Factorial with three replication. Application of Sulfosulfuron @ 75 kg/ha, resulted the lowest density and dry weight of yield attributes which produced the highest straw and grain yield, biological yield and protein content.

Keywords: Herbicides, irrigation, barley, growth, yield and yield attributes

1. Introduction
The Barley is popularly known as "Jau" in Bundelkhand region in (U.P.). It has been grown in India since ancient time and used in most of the religious occasions. It is a "poor man's crop" to be grown basically in unirrigated part of the country under the limited inputs. However, thick coating of the husk has reduced very badly its food value. If dehulling of the husk is not done it spoils badly the quality of 'chapati' 'sattu' and roasted grain etc. as well as digestion of the food. Barley is recommended for those who are suffering from dysentery, diarrhea etc. In general barley gives a cooling effect to the body. Generally its grain contains 11.5% protein, 69.6% carbohydrate, 1.3% fat 3.9% crude fibers, 1.2% mineral matter 0.26% Calcium and 0.22% phosphorus. It is also used to prepare malt for manufacturing beer and other products such as industrial Alcohol and vinegar. Malt syrup is also utilized for making candies, medicines and in textile industry. The grains are also used for manufacturing pearl and power products. Surplus grain provides feed for cattle and horses etc. Barley is an important Rabi cereal crop of India ranking next to wheat rice and maize both in acreage and in the production of grain. In India it is mostly grown in semi-arid regions with limited water supply having low and moderate fertility status of the soil. Therefore, the aria under this crop has been fluctuating very rapidly from year to year. The major constraints limiting production of fertility, rain fed cultivation with recurring drought, application of practically no cash input like fertilizer and plant protection measures, dearth of a remunerative market for produce because of the lack of appreciation about the nutritive value of this crop. Barley is an important cereal crop in world agriculture. It occupies fourth position in the world acreage after wheat, rice and maize and third in total cereal production. The countries where barley is grown as an important cereal crop are Russia (C.I.S.), U.S.A. Turkey, France, Canada, China, Morocco, U.K. Spain, Germany and Australia Russia (C.I.S.) being the largest producer of barley with Russia largest country in the world (6.612 sq mil) – 15.388704 lakh tens.

In India barely crop is grown over an area of 6.50 lakh hectares with the production of 17.00 mt/hac and in year 2020, 2021 (grain and feed Annual report 2021. USDA) U.P. is one of the most important barley growing state in India with an area contribution 44.02% and 48.9% to the total aria and production respectably to barley crop in country U.P. They have a total Agriculture aria of 36.65% of the purpose of barley cultivation. They account 40.11% of the barley cultivations in this the country. Rajasthan (24.93%). Haryana (8.2%) Punjab (7.9%) and M.P. (5.19%) etc. (Barley Rabi cereal, Annual Report 2021 C.S.A. & University of Agril. & Tech. Kanpur). U.P. contributes 43.82% and 47.05% to the total area and production respectively; of barley crop in the country U.P. has a great significance both in area and production of the barley crop. The availability of the improved high yielding cultivars of barley has resulted in better production in relation to the farmers in the states of U.P. Haryana and Rajasthan. The timely well distributed rains during the crop season had helped to harvest a very good rained crop in eastern U.P. and other barley growing states. Agriculture in most of the part of India is still a gamble in hand a of monsoon rains which are uncertain and extremely variable with reference to their onset, distribution and cessation about 69.5 percent of cultivated land in the country is under dry land and rained forming. Estimates show that besides of all possible resources to bring more and more area of cultivated land under assured irrigation in the country. National commission on agriculture is of the opinion the only 40 percent area can be provided with irrigation while remaining 60 percent of land area will depend upon mansion rains. Herbicide Application the control of phantasies minor and will Qat (Avenafatua) spray Isoproturon 75 WP at the rate of @ 1.0 lit/ha or panda metallic (stomp) 30 EC at the rate of 3.3 litmus in 600-800 liters of water 2-3 Days after sowing. Applications of 24 d sodium salt (80%) or 2.4 D amine salt (72%) at @ 0.75 kg A.I/ha in 700-800 litmus of water per ha. 30-40 Days after sowing of the crops. The above accounts demonstrates the justifications to balance the demand and supply to least different yield deciding factors *viz.* herbicides, improved seeds and fertilizers in a single field experiment under the conditions of Bundelkhand region in U.P. Thus the present investigation entitled "Effect of herbicides and irrigation levels on growth and yield of barley [*Hordeum vulgare* (L.)] Was carried out during Rabi season of 2020-2021 at the Agriculture Research Farm of Brahmanand PG College, Rath (Hamirpur) UP with the following objectives. To study the effect of herbicides on growth and yield of barley to study the effect of irrigation levels growth and yield of barley crop. To determine the interaction effect of herbicides and irrigation levels, to work out the economics/beneficial combination for barley production in Bundelkhand region.

2. Materials and Methods

The present experiment was conducted at the Research Farm of Brahmanand Post Graduate College, Rath (Hamirpur) U.P. during the rabbi season of 2020-21. The Farm is situated near Rath town on Rath Mahoba bus route in southern region of Bundelkhand (U.P.). The experimental field has assured irrigation facilities and good drainage system with moderate slope towards the direction from West to East. The soil of experimental field was 'PARWA' a type of Bundelkhand soil having texture of silty loam with slightly alkaline in reaction (pH 7.6) It was low in phosphorus but high in available potassium content. The electrical conductivity and calcium carbonate content of the soil was (4.0 m.mhos/cm.) at 25 °C and 4.18 percent, respectively. Geographically Rath, Hamirpur district lies in the sub- tropical zone at a latitude and longitudinal range of 79.7° East and 25.5° North. It is located to an elevation of 526 feet's from the sea levels. The annual rainfall ranges between 900-1000 received mostly from last week of June to Last September with occasional showers in winter. Bundelkhand has sub-tropical climate with hot Days during summer and cold in winter. The mean weekly temperature (maximum and minimum), relative humidity and total rainfall were recorded from the meteorological observatory of Indian Grassland and fodder Research Institute (IGFRI, Jhansi) U.P. The first ploughing was done by soil turning plough by which field conditions became workable. Further ploughing were given by Deshi plough followed by two harrowing and planking were done to make the soil firm and friable for ensuring better germination of Herbicide Application the control of phaleris minor and will Qat (Avenafatua) spray Isoproturon 75 WP at the rate of @ 1.0 lit/ha or panda methalin (stomp) 30 EC at the rate of 3.3 litmus in 600-800 liters of water 2-3 Days after sowing. Applications of 2 4 d sodium salt (80%) or 2.4 D amine salt (72%) at @ 0.75 kg A.I/ha in 700-800 litmus of water per ha. 30-40 Days after sowing of the crops.

3. Results and Discussion

3.1 Plant height: Data presented in Table 1 and Fig 1 and statically analysed data are given in clearly indicate that at 30 DAS stage. The herbicides and levels of irrigation have -non significant response on plant height the minimum and maximum (12.80 and 12.90 cm) plant, height recorded w2 and w0 herbicides, respectably. The variation and plant height due to levels of irrigation was non-significant the minimum (16.01) and maximum (17.52 cm) plant height were recorded I2 and I3 levels of irrigation, respectably. The interaction of herbicides and levels of irrigation on plant height on 60 DAS stage was -non significant. At 60 DAS stage the significant levels (48.69 cm) plant height was recorded with w0 (no herbicides. The maximum (53.83 cm) plant height was recorded with w3 which was significantly higher of w0 and w1 and statistically of par with w 2. At 60 Das the plant height increase significantly with each increased in level of irrigation the significantly levels on higher (46.00cm) and (17.44 cm) plant height were recorded with I0 and I3 levels of irrigation respectably.

3.2 Fresh weight per plant: The data recorded fresh weight per plant indicate that fresh bet per plant of crop. At harvest stage at digressed due to depletion of moisture from plant cell, At 30 DAS stage the herbicides have no significant response on fresh per plant. The minimum and maximum (6.06 and 6.12 am) fresh weight per plant were recorded with W2 and W3 herbicides, respectably. The W0 (6.12) and W3 (6.12) were found to produce q/ha fresh weight per plant. The fresh weight per plant with increase number of irrigations, number of irrigations also has -non significant response on fresh weight per plant the minimum and maximum (7.9 and 8.03 cm) fresh weight per plant were recorded with I0 and I3 number of irrigation respectively. The interaction effect of herbicides and number of irrigation on fresh weight per plant (WXI) was found-non significant. At 60 DAS stage, 90 DAS

and at harvest stages the significantly highest (7.14, 12.34, and 9.59 cm) fresh weight per plant was recorded with w2 (24 D sodium salt 80%). The significantly lost (5.34, 9.34, and 7:14 g) fresh weight was recorded at 60, 90 and at harvest stages with W0 no herbicides use. The number of irrigation have also significant response on fresh weight per plant at 60, 90 at harvest stages, the fresh weight was found to increased significantly were each increased number of irrigation 60,90 and at harvest stage, respectably. The significantly (9.94, 12.25 and 13.27 q) value was recorded with (60, 90 and at harvest) stages were recorded with I3 at 60, 90 at harvest stage, respectively.

3.3 Attributes: The variance in the main yield attributing character like number of ear per running meter, average length of ear, average weight per ear, number of grains per ear, average weight of grains per ear, number of spikelets per ear (fertile/sterile) and test weight due to the treatment effect were measured and the results were subjected to statistical analysis The data pertaining to all the yield attributes have been summarized and present in table 3 and illustrated graphically.

3.4 Number of effective tiller per plant: The herbicides have significant response on tiller per plant the significantly lowest (2.02) number of affection tillers per plant was recorded with w0 (No herbicides). The maximum 2.41 number of effected tiller per plant was recorded with W3 (sulfosulfuron75 wp @ 1 ltr/ha) which was significantly higher over w0 and w1 herbicides. The W3 and W2 (2.33) were statistically at par. Levels of irrigation have also significant response on number of effective tiller per plant the effective tiller per plant were found to increased with each increased in irrigation level. The significantly lowest (2.43) number of effective tiller of per plant was recorded with I0. The maximum (3.45) number of effective tillers per plant was recorded with I3 which was significantly higher our I0 and I2 levels of irrigation. The I3 and I2 (3.40) were statistically at par. The interaction effect of herbicides and irrigation levels (WxI) on number of effective tiller was found significant.

3.5. Average length of spike: Data presented Table 3 and Fig 3. Clearly indicate that herbicides have significant response on average length of spike the significantly lowest and height (10.82, 12.44 cm) average length of spike was recorded with W0 W3 herbicides, respectively. Irrigation leaves have also significant response on average length of spike the average length of spike increased significantly with each increased in irrigation levels. The minimum and maximum (14.72) and (16.21) cm average length of spike was recorded with I0 and I3 levels of irrigation respectively.

3.6 Number of grain per plant: No. of grain per plant data in Table 3 Fig 3 clearly indicate that herbicides significant response are number of grain per plant. The significantly lowest (95.70) number of grain per plant was recorded with W0. The maximum (106.08) number of grain per plant was recorded with W2 which was significant higher over w0 and w1 the w2 and w3 (10.17) were statistically at par.

3.7 Weight of grain per plant: Data presented in table number and 3 and Fig 3 clearly indicate that herbicides have significant response on grain weight per plant was recorded with W2 (24 D sodium salt 80%) the significantly lowest (2.94 g) grain weight per plant was recorded with w0 (No. herbicides). The respectively ordered of herbicides regarding grain per plant can be return w2>w3>w1>w0 Level of irrigation has also significant response on grain weight per plant. The grain weight per plant increased significantly within each increase in level of irrigation. The signification highest and lowest (5.38 and 3.14 g) grain weight per plant was recorded with I3 and I0 level of irrigation, respectably. Interaction effect of herbicides and irrigation levels on grain weight per plant was found significant.

3.7 Number of fertile spikelet per spike: Data presented in Table 3, Fig 3 clearly indicate the herbicides different significantly among each other regarding number of fertile spikelet per spike the significantly lowest and highest (15.95 and 14.08) number of fertile spikelet per spike was recorded with w0 and w3 herbicides respectively.

3.8 Number of fertile spikelet per spike: Data presented in Table 3, Fig 3 clearly indicate the herbicides different significantly among each other regarding number of fertile spikelet per spike the significantly lowest and highest (15.95 and 14.08) number of fertile spikelet per spike was recorded with w0 and w3 herbicides respectively. Similarly levels of irrigation have also significant response number of fertile & spikelet per spike. The number of fertile spikelet per spike increases with (I) each increase in levels of irrigation. The minimum and maximum (22.58) number of sterile spikelet per spike was recorded w3. The number of sterile spikelet per spike decried with each increased in levels of irrigation. The significantly higher and lowest (5.60 and 4.02 number of sterile spikelet per spike were recorded with I0 and I3 level of irrigation, respectively).The interaction effect of herbicides and irrigation levels on fertile spikelet per spike was non-significantly.

3.9 Test Weight (g): The data presented in Table 3, Fig 3 clearly indicate that the herbicides and significant response on test weight the significantly lowest (30.99g) test weight was recorded with w0 (no. herbicides). The maximum (34.08 g) weight was recorded did with w3 (Sulfosulfuron 75 wp) which was significant & higher over w0 and w1 herbicides w3 was statistically at par. with w2 (34.01 g).Similarly irrigation levels have also significant response on test weight. The significantly lowest (41.02g) test weight was recorded with I0 They the maximum (45.01g) test weight was recorded with I3 irrigation levels which was significantly higher over I0 and I1 level of irrigation. I3 and I2 levees of irrigation were statistically at per regarding test weight.

3.10 Harvest Index: W3 which was significant by higher over w0 and w1, W1 (44.09%) harvest index was recorded with w0 which was significantly lowest comp early w2 and w3 the levels of irrigation have also significant response on harvest index. The increased with Increased in level of irrigation the significantly lowest 58.36 harvest index was recorded with w0 were as the maximum 59.58% harvest index I3 level of irrigation.

Table 1: Height of plant (cm.) at successive stage of crop growth as influenced by different treatments

Treatments	Days after sowing			
	30	60	90	At harvest
Herbicides kg ha^{-1}				
W0 (Control)	12.77	48.69	62.78	66.53
W1 (Pendimethalin)	12.87	51.65	68.99	75.83
W2 (2 4 D)	12.90	53.89	74.41	81.09
W3 (Sulfosulfuron)	12.81	53.89	77.00	83.26
S.E. (d) ±	0.05	0.08	0.10	0.13
C.D. at 5%	N.S.	0.18	0.21	0.27
Irrigations				
I0 (Control)	16.01	67.00	78.57	84.24
I1 (First irrigation)	17.43	69.89	90.10	99.68
I2 (Two irrigations)	17.52	70.18	101.67	112.23
I3 (Three irrigations)	17.52	70.44	107.33	112.78
S.E. (d) ±	0.05	0.08	0.10	0.13
C.D. at 5%	0.10	0.18	0.21	0.27

Table 2: Fresh weight per plant (g) as influenced by different stages of growth

Treatments	Days after sowing			
	30	60	90	At harvest
Herbicides kg ha^{-1}				
W0 (Control)	6.12	5.39	9.34	7.19
W1 (Pendimethalin)	6.11	6.06	10.52	8.09
W2 (2 4 D)	6.06	7.19	12.39	9.59
W3 (Sulfosulfuron)	6.12	6.80	11.83	9.01
S.E. (d) ±	0.10	0.05	0.10	0.05
C.D. at 5%	N.S.	0.10	0.21	0.10
Irrigation levels				
I0 (Control)	7.90	5.77	9.90	7.70
I1 (First irrigation)	8.11	8.46	14.88	11.33
I2 (Two irrigations)	8.27	9.64	16.76	12.88
I3 (Three irrigations)	8.30	9.94	17.25	13.27
S.E. (d) ±	0.10	0.10	0.52	0.10
C.D. at 5%	0.21	N.S.	0.10	0.21

Table 3: Yield attributes as influenced by different treatments

Treatments	Tiller per plant at harvest	Length of spike (cm.)	Grain per plant	Grain weight per plant	Fertile spike	Sterile spike lees per spike	Test weight per spike
Herbicides (kg/ha)							
W0 (Control)	2.02	10.8	95.7	2.94	15.95	3.80	30.29
W1 (Pendimethalin)	2.31	11.67	101.25	2.29	16.5	4.02	32.00
W2 (2 4 D)	2.33	11.91	106.18	3.89	18.68	3.51	34.01
W3 (Sulfosulfuron)	2.41	12.44	106.17	3.60	19.08	2.83	34.08
S.E. (d) ±	0.12	0.05	0.16	0.05	0.16	0.05	0.10
C.D. at 5%	0.24	0.11	0.32	0.11	0.33	0.11	0.20
Irrigation levels							
I0 (Control)	2.43	14.72	90.91	3.14	22.58	5.60	41.02
I1 (II rrigation)	3.12	15.46	142.91	4.54	22.91	4.92	42.80
I2 (III rrigation)	3.40	15.99	153.67	5.20	23.89	4.33	45.01
I3 (IIII rrigation)	3.45	16.21	158.23	5.38	24.23	4.02	45.01
S.E. (d) ±	0.12	0.05	0.16	0.05	0.16	0.05	0.10
C.D. at 5%	0.24	0.11	0.32	0.11	0.33	0.12	0.20

Table 4: Yield per unit area as influenced by different treatments

Treatments	Total producer weight (q/ha)	Grains yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Herbicides (kg/ha)				
W0 (Control)	59.54	26.29	33.45	44.09
W1 (Pendimethalin)	66.64	29.50	37.12	44.15
W2 (2 4 D)	73.76	32.76	41.18	44.36
W3 (Sulfosulfuron)	73.73	32.92	40.73	44.50
S.E. (d)	0.05	0.05	0.15	0.10
C.D. at 5%	0.11	0.10	0.32	0.20
Irrigation levels				

I0 (Control)	57.2	25.02	32.41	58.36
I1 (I Irrigation)	94.0	41.58	52.33	58.80
I2 (II Irrigation)	105.5	47.00	58.5	59.39
I3 (III Irrigation)	108.19	48.34	60.06	59.58
S.E. (d) ±	0.05	0.05	0.16	0.10
C.D. at 5%	0.11	0.10	0.32	0.20

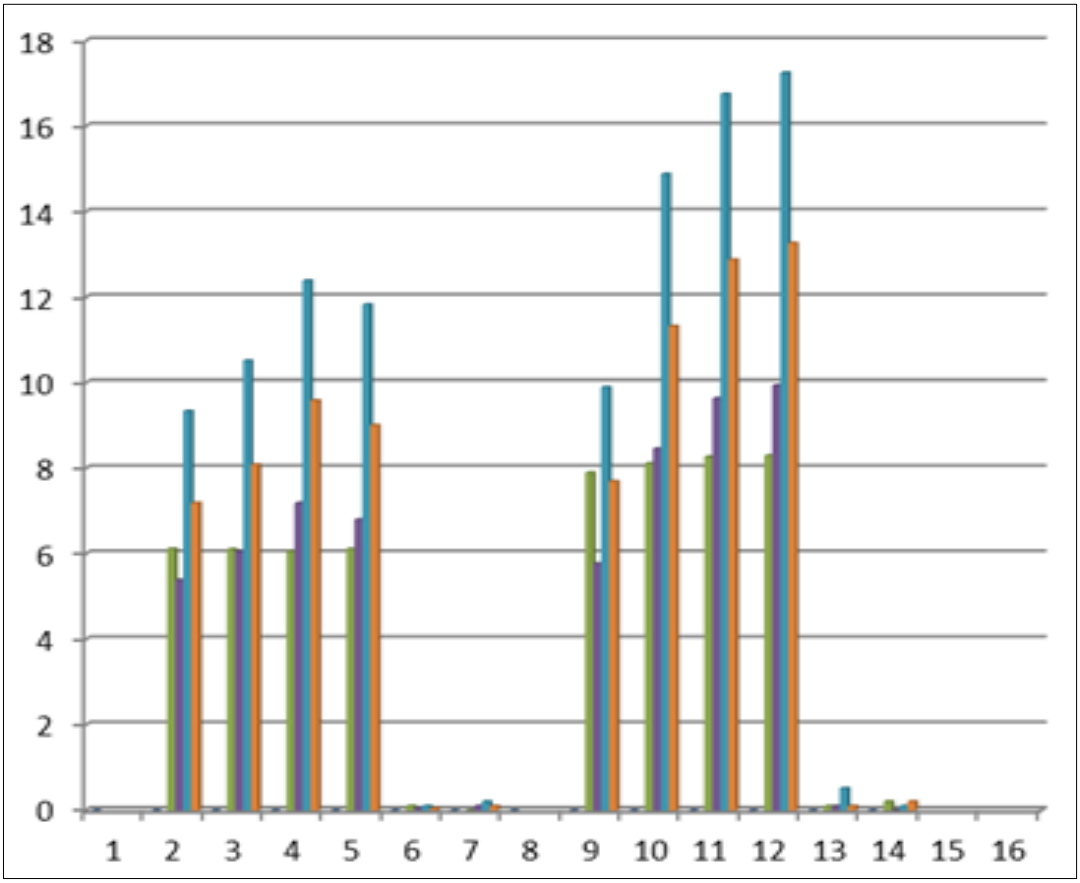

Fig 1: Height of plant (cm.) at successive stage of crop growth as influenced by different treatments

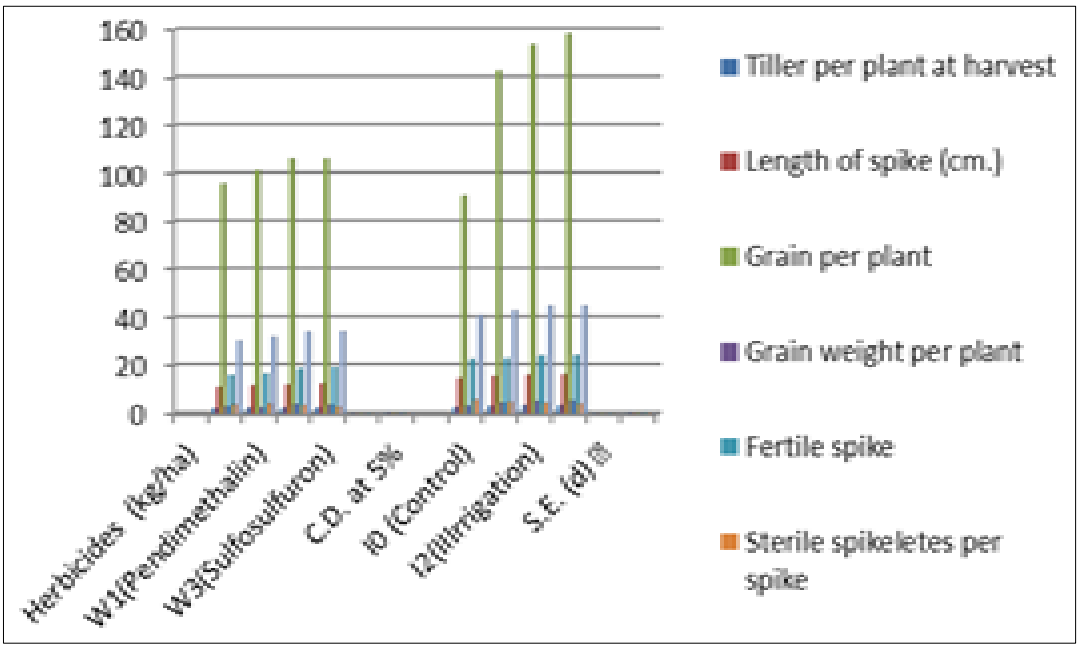

Fig 2: Yield attributes as influenced by different treatments

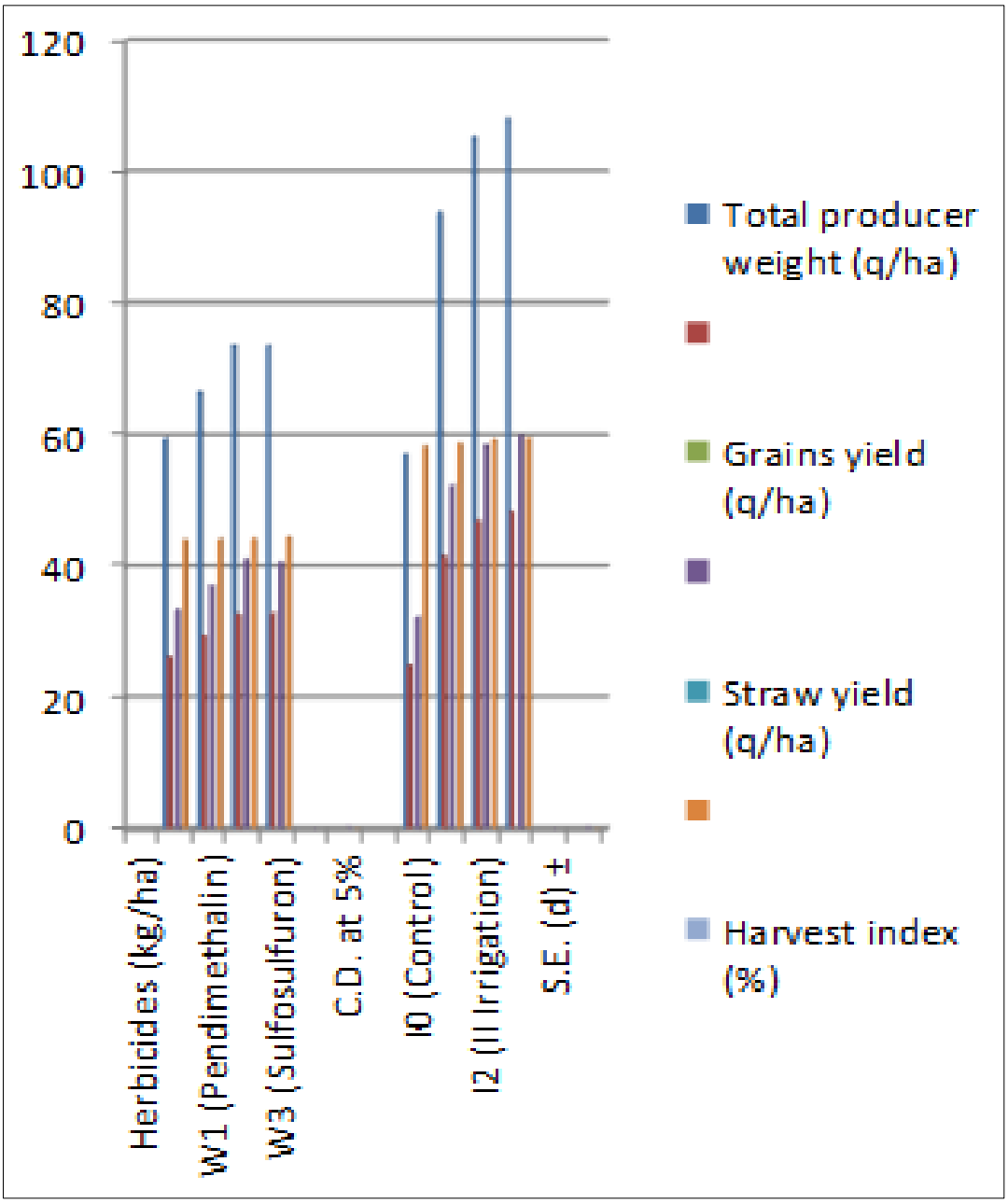

Fig 3: Yield per unit area as influenced by different treatments

4. Conclusions

With the values of the results in the present investigation the following main conclusions can be drown. (24 D sodium salt 80% EC) was found most suitable herbicides followed by sulfosulfuron 75 wp in Bundelkhand region. Irrigation at 25 DAS, 2nd irrigation at 55 DAS thirds irrigation at 85 DAS were found most irrigation sodium as compared to lower irrigation levels for Barley crops. The 24 D sodium salt 80% along with three irrigation I irrigation at 25 DAS, III irrigation at 55 Day, 3rd irrigation at 85 DAY. Produce and total produce graining and straw yield. This treatment combination practices (Rs. 7.76) Investment with was closely followed by w3 I3 and W2 I2 treatment combination.

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