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Effect of fertility levels and weed control methods on growth parameter of Barley in Bundelkhand Region Uttar Pradesh (*Hordeum vulgare* L.)

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Abstract
At Brahmanand Post Graduate College's research farm in Rath (Hamirpur), Uttar Pradesh, during the Rabi season of 2018–2019, an investigation done "Under the Condition of the Bundelkhand Region in U.P." was undertaken. The variables involved in this study were four methods of weed control, i.e., W0 (control), W1 (mechanical method), W2 (2,4-D @ 625 g/ha at 30 DAS), and W3 (Sulfosulfuron 75WG 33 g/ha) with four levels of fertilizers, *viz.*, F0 (00.00.00 NPK kg/ha), F1 (40:20:20 NPK kg/ha), F2 (60:30:30 NPK kg/ha), and F3 (80:40:40 NPK kg/ha). The above treatments were treated in all possible combinations; hence, there were sixteen treatment combinations arranged in a randomized block design with three replications. The soil of the experimental site was "PARWA" (silty loam), having a soil pH of 7.3, being low in available nitrogen and organic carbon, medium in available phosphorus, and medium in available potassium. The treatment effect on the growth and yield of the crop were determined, and the important findings of the investigation are. The level of fertility, F3 (80:40:40 NPK kg/ha), was found to be non-significant, except for functional leaves per plant and fresh weight (gm) at all the growth stages (30, 60, 90 at harvest) of the crop. The weed control method W3 (Sulfosulfuron) was found to produce the highest value of plant height (cm), number of functional leaves per plant, fresh weight (gm) per plant.

Keywords: Growth, barley, weed, NPK, fertility, significant

Introduction
Barley (*Hordeum vulgare* L.) is self-pollinated, annual monocotyledonous crop belonging Gramineae family. It is the most important food grain crop among the cereals and stands next to the wheat in India. It has significantly contributed in the success of green revolution. It is a major source of food for large number of people living in the cooler semi-arid areas of the world, where wheat and other cereals are less well adapted. It is a stable food of the people in the Tibet, Nepal and Bhutan. In European countries it is used only as breakfast food. The leading countries of its production are USSR, China, France, Canada, USA, Spain and India.

The structural component of barley grain has approximately 75% endosperm 7-15% husk 1-3% testa, 2-5% embryo and aleuron and a nucellar layer of 7-12%.

Barley is a nutritionally very important crop as it contains 65-68% starch, 10-17% protein, 4-9% beta-glucan, 2-3% lipids and 1.5-2.5% minerals (Czuchajowska *et al*., 1998; Izydorczyk *et al*., 2000; Quinde *et al*., 2004; Sharma and Gujral, 2010, Sharma *et al*., 2011) [22, 23, 14, 17, 18].

Barley growing area in the world is approximately 49.02 million hectares resulting in 139.8 1 million metric tones production with an average productivity of 2.85 tones per ha at global level. The major barley cultivating countries in the world are Russia Federation, Australia, Germany, France, Ukraine, Canada, U.K. Turkey, Spain and Denmark (USDA, 2019)

In India, barley covers about of 0.68 million hectares area resulting in production of 1.77 million metric tons with productivity of 2.61 tons per hectares. The barley cultivation in India is taken up in Uttar Pradesh, Rajasthan, Bihar, Haryana, Madhya Pradesh, West Bengal, Himachal Pradesh, and Jammu and Kashmir.

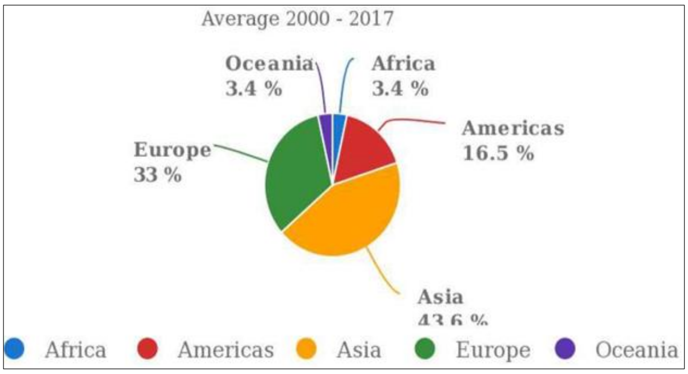

Fig 1: Production share of wheat by region

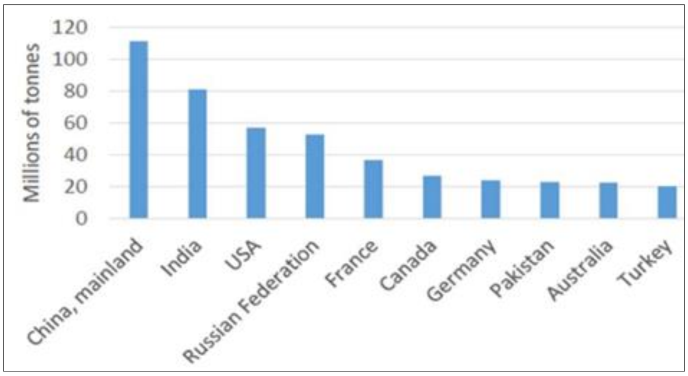

Fig 2: Production of wheat: Top 10 producers

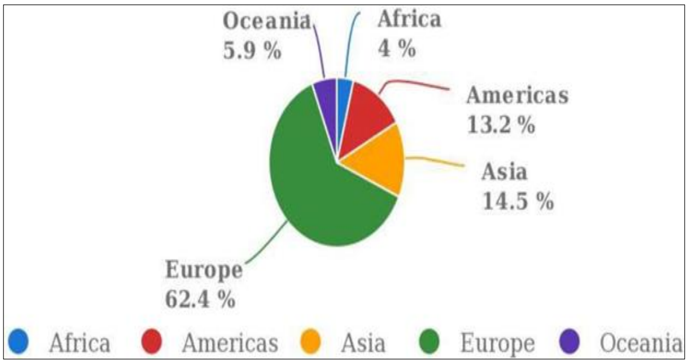

Fig 3: Production share of barley by region

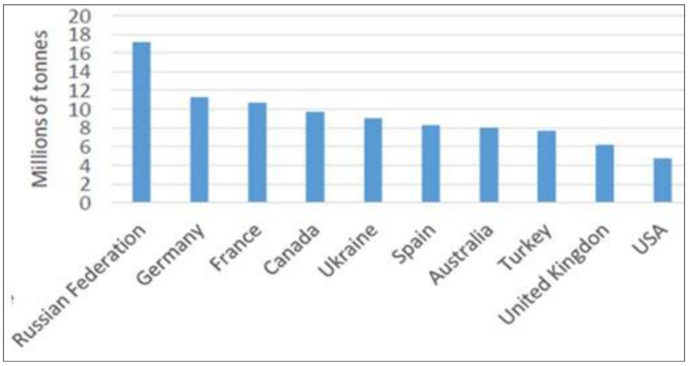

Fig 4: Production of barley top 10 producers

The Bundelkhand region of UP is a sub-tropical part of state and soil are more suitable for oil seeds and pulses but barley crop is also grown under rainfed and irrigated conditions in large areas. The production and productivity of barley in this region is low due to limited irrigation facility, application of less amount of fertilizers (NPK) and showing of local or unimproved varieties and limited use of weed control methods. The judicious fertilization together with improved varieties and irrigations have an important role in maximizing the yield of barley crop in this region.

Among the important factors affecting the growth, yield and quality of barley crop are manure and fertilizers, suitable varieties and timely irrigation and suitable weed control methods. It has been conclusively proved by several workers in the field of agriculture that Indian soil are mostly deficient in nitrogen, some in phosphorus and other essential nutrients.

In this crop, the nutrient nitrogen has great important during crop period. In the early stage it improves the germination and suitable plant stand and on later stages, it helps to increase tillering, earing and boldness of grains. Therefore, fertilizer combinations and weed control methods have good response.

Materials and Methods

The present experiment was conducted at the research farm of Brahmanand Post Graduate College, Rath (Hamirpur) U.P. during Rabi season of 2018-2019. The farm is situated near Rath town on Rath-Mahoba by route in southern region of Bundelkhand (U.P.) the field has irrigation facilities and good drainage system with moderate slope towards the direction from West to East.

Soil status

The soil of experimental field was PARWA a type of Bundelkhand soil having texture of silty loam with slightly alkaline in reaction (pH 7.3). It was low in Phosphorus but high in available potassium contant, the electrical conductivity and organic carbon of the soil was 0.43 m mohs/cm at 25°c and 0.71% respectively.

The important physico-chemical properties of soil are illustrated in table -1.

Table 1: Mechanical and physic- chemical properties experimental site.

S. No.	Soil Component	Contant	Method Used
A. Mechanical Properties			
1	Coarse sand (%)	29.43	International pipatte method (Piper,1950)
2	Silt (%)	47.00	
3	Clay	23.57	
4	Taxture	Silty loam(PARWA)	
B. Physico-Chemical Properties			
1	Soil pH	7.3	By mini soil testing kit IISS Bhopal at KVK Mahoba
2	Electrical Conductivity (m.mosh/cm)	0.43	------do------
3	Organic Carbon (%)	0.71	------do------
4	Available Nitrogen(Kg/ha)	221	------do------
5	Available Phosphorus(Kg/ha)	29	------do------
6	Available Potassium (Kg/ha)	224	------do------
7	Available Sulphur (ppm)	10.3	-------do------

8	Available Zn (ppp)	0.26	-------do------
9	Available B (ppm)	0.39	-------do------
10	Available Fe (ppm)	7.1	-------do------

Experimental Details

Treatments

The experiment was conducted with the following treatments.

Table 2: Levels of fertilizer (Kg/ha)

Symbol	Nitrogen	Phosphorus	Potassium
F_0	Control	Control	Control
F_1	40	20	20
F_2	60	30	30
F_3	80	40	40

B. Weed control method

Symbol

W_0- Control

W_1- Mechanical method

W_2- 2,4-D 80% WP @ 625g./ha.

W_3- Sulfosulfuron 75 WG 33g./ha.

Experimental design Factorial RBD, Number of replication 3, No. of treatments 16 and Total number of plot 48.

The fertilizer dose in combination (NPK) were applied through Urea, single super phosphate and murate of potash, respectively. The half dose of nitrogen and full dose of phosphorus and potash were given as basal at the time of sowing and remaining half of nitrogen was applied as top dressing after first irrigation or 30 days after sowing. Particular of the observation regarding periodic growth data and yield attributing characters are given below in Initial plant population

Data obtained from each season of the study statistically analyzed according to procedures outlined by Gomez and Gomez (1984) using MSTAT-C computer program (Freed *et al*. 1989). Test for homogeneity of variance was used to compare between variances over two years before deciding the validity of combined analysis. The differences among treatments means were compared by Least Significant Differences test (L.S.D) at 0.05.

Result and Discussion

Plant Height (cm.)

The height of main shoot is an important plant character which provides an idea about the growth, the results on shoot height as influenced due to different treatments are presented in table 3.

Table 3: Height of main shoot (cm) as influenced by different treatments at various stages of crop growth.

Treatments	Days after sowing			At harvest
	30	60	90	
F_0	12.77	48.69	62.78	67.02
F_1	13.86	51.66	69.00	74.57
F_2	16.38	54.41	74.92	81.08
F_3	16.67	56.83	78.00	83.75
S.E.(m) ±	0.05	0.09	0.11	0.13
C.D. at 5%	0.11	0.18	0.21	0.26
Weed control methods				
W_0	19.18	67.56	78.57	84.23
W_1	20.07	70.90	90.01	99.68
W_2	20.15	72.00	101.67	109.89
W_3	20.16	71.66	109.33	114.78
S.E.(m) ±	0.05	0.09	0.11	0.13
C.D. at 5%	0.11	0.18	0.21	0.26

Table 4: Show the plant height at 60 DAS and 90 DAS interaction (FXW) effect

Plant height at 60 DAS interaction (FXW) effect.					Plant height at 90 DAS interaction (FXW) effect				
F/W	W_0	W_1	W_2	W_3	F/W	W_0	W_1	W_2	W_3
F_0	46.33	49.07	49.37	50.00	F_0	56.00	60.07	65.03	70.00
F_1	50.03	52.62	51.96	52.00	F_1	58.03	64.97	72.96	80.00
F_2	52.33	54.00	56.67	54.66	F_2	59.67	70.00	82.00	88.00
F_3	53.2	51.5	50.23	50.45	F_3	57.78	69.34	81.34	87.23
S.E.(m)	0.20				S.E.(m)	0.24			
C.D	0.41				C.D	0.49			

Data presented in table -3 and reveal that at 30 days stage the each increase in fertility levels the plant height increased significantly. The significantly lowest and highest (12.77 and 16.67) plant height were recorded with F_0 and F_3, respectively. At 60 days stage the plant height was found to increase in significantly with each increase in fertility levels. The minimum and maximum (48.69 and 56.83cm) plant height were recorded with F_0 and F_3 fertility levels, respectively. Similarly at 90 days stage the plant height increased significantly in weed control methods. The significantly lowest and heights (78.57 and 109.33cm) plant height were recorded with W_0 and W_3 weed control methods respectively.

Similarly plant height at harvest stage in weed control methods significantly lowest and highest (84.23 and 114.78 cm) plant highest were recorded with W0 and W3 weed control methods, respectively.

Table 4 clearly indicates that the interaction effect at 60 DAS significantly lowest (46.33cm) plant height was recorded with the F0 W0 treatment combination. The significantly highest (58.33cm) plant height was recorded with the F3 W3 treatment combination, which was statistically on par with the F3 W2 treatment combination over all. Plant height increased with each increase in fertility level and weed control methods. The lowest plant heights were recorded with W0 and W3.

Table 4 clearly indicates that the interaction effect of 90 DAS for each treatment combination differs significantly among each other. The plant height increased significantly with each increase in the minimum W0 and maximum W3 weed control methods. The significantly lowest and highest (56.00 and 90.00 cm) plant heights were recorded with the F0 W0 and F3 W3 treatment combinations

Number of functional leaves per plant

The Data presented in Table 5 and indicate that number of functional leaves per plant were found to differ with fertility levels at different stages of growth

Table 5: Number of functional leaves per plant at different growth stages as influenced by fertility levels and weed control methods.

Treatments	Days after sowing		
	30	60	90
F_0	6.53	17.28	20.53
F_1	7.49	18.99	21.24
F_2	7.50	22.17	21.33
F_3	7.50	23.50	22.75
S.E. (m). ±	0.09	0.11	0.12
C.D. at 5%	0.18	0.21	0.24
Weed control methods			
W_0	8.68	24.23	26.90
W_1	9.34	26.68	28.34
W_2	10.33	29.00	29.22
W_3	10.33	29.33	30.00
S.E. (m). ±	0.09	0.11	0.12
C.D. at 5%	0.18	0.21	0.24

Table 6: Functional leaves at 60 DAS interaction and 90 DAS interaction (FXW) effect

Functional leaves at 60 DAS interaction (FXW) effect.					Functional leaves at 90 DAS interaction (FXW) effect				
F/W	W_0	W_1	W_2	W_3	F/W	W_0	W_1	W_2	W_3
F_0	14.00	17.07	19.03	19.00	F_0	20.00	20.07	21.03	21.00
F_1	18.03	18.97	18.96	20.00	F_1	20.03	20.97	20.96	23.00
F_2	20.67	22.00	23.00	23.00	F_2	20.67	21.00	21.67	22.00
F_3	20.00	22.00	26.00	26.00	F_3	20.00	23.00	24.00	24.00
S.E.(m)	0.24				S.E.(m)	0.27			
C.D	0.49				C.D	0.55			

The number of functional leaves were found to increase with F_1F_2andF_3fertility levels at 30 days to stage, the maximum (7.50) No. of leaves per plant were recorded with an F_3 fertility level that was on par with F_1 (7.49) and F_2 (7.50). The significantly lowest (6.53) number of functional leaves per plant was recorded with an F_0 (no N.P.K.) fertility level.

Similarly, the lowest (8.68) number of functional leaves per plant was recorded with W_0. The maximum (10.33) number of functional leaves per plant was recorded with W_2 and W3, which was significantly higher as compared with W_1 and W_0 weed control methods.

At the 60-day stage, the number of functional leaves was found to increase significantly with each increase in fertility level. The significantly highest and lowest (23.50 and 17.28) numbers of functional leaves were recorded with F_3 and F_0 fertility levels, respectively.

Similarly, the number of functional leaves per plant was found to increase significantly with continued use of weed control methods. The minimum and maximum (24.23 and 29.33) numbers of functional leaves per plant were recorded with the W_0 and W_3 weed control methods, respectively.

The interaction effect of fertility levels and weed control methods (FXW) on the number of functional leaves per plant was found to be significant at the 60-day stage.

The number of functional leaves almost doubles with each increase in fertility levels and weed control methods. The significantly lowest (14.00) number of functional leaves per plant was recorded with the F_0W_0 treatment combination, whereas the significantly highest (26.00) number of functional leaves per plant was recorded with the F_3W_3 and F_3W_2 treatment combinations.

At the 90-day stage, the number of functional leaves was found to increase with each increase in fertility level. The significantly lowest and highest (20.53 and 22.75) numbers of functional leaves were recorded with F_0 and F_3 fertility levels, respectively. The F_1 (21.24) and F_2 (21.33) fertility leaves were statistically at par.

The number of functional leaves per plant increased significantly with weed control methods. The minimum and maximum (26.90 and 30.00) numbers of functional leaves per plant were recorded with W_0 and W3, respectively, at 90 days.

The interaction effect of fertility levels and weed control methods was found to be significant on the number of functional leaves per plant at the 90-day stage.

The significantly highest (24.00) number of functional leaves per plant was recorded with F_3 W_2 and F_3 W_3 treatment combinations. The minimum (20.00) number of functional leaves per plant was recorded with the F_0 W_0 treatment combination, which was significantly lower than all the treatments except F_1 W_0 and the F_0 W_1 treatment combination.

Fresh weight per plant

Table 7: Fresh weight per plant at different growth stages as influenced by fertility levels and weed control methods.

Treatments	Days after sowing			At harvest
	30	60	90	
F_0	6.13	4.47	5.16	21.58
F_1	6.70	4.96	5.72	22.60
F_2	7.02	7.11	8.14	22.35
F_3	7.10	11.32	12.19	23.22
S.E. (m). ±	0.11	0.05	0.11	0.05
C.D. at 5%	NS	0.11	0.21	0.11
Weed control methods				
W_0	8.70	7.55	8.53	28.41
W_1	8.81	9.20	10.41	30.70
W_2	9.20	9.27	10.74	29.87
W_3	9.20	11.11	11.94	30.68
S.E.(m) ±	0.11	0.05	0.11	0.05
C.D. at 5%	NS	0.11	0.21	0.11

Table 8: Fresh weight at 60 DAS interaction and Fresh weight at 90 DAS interaction (FXW) effect

Fresh weight at 60 DAS interaction (FXW) effect					Fresh weight at 90 DAS interaction (FXW) effect				
F/W	W_0	W_1	W_2	W_3	F/W	W_0	W_1	W_2	W_3
F_0	3.85	4.42	4.74	4.83	F_0	46.46	5.10	5.48	5.59
F_1	4.39	4.76	5.19	5.48	F_1	5.07	5.51	6.01	6.30
F_2	5.71	7.19	6.80	8.71	F_2	6.27	8.31	7.87	10.08
F_3	8.69	11.23	11.05	14.30	F_3	9.78	12.28	12.85	13.86
S.E.(m)	0.12				S.E.(m)	0.24			
C.D	0.24				C.D	0.49			

The data presented in tables 7 and 8 indicate that fresh weight per plant increased abruptly up to the 90-day stage of the crop. At harvest, it decreased due to the depletion of moisture from plant cells.

At the 30-day stage, the significantly lowest (6.13 g) fresh weight per plant was recorded with the F_0 fertility level. The maximum (7.10 g) fresh weight per plant was recorded with F3, which was significantly higher than F_0 and F_1 fertility levels. The F_3 (7.10 g) and F_2 (7.02 g) fertility levels were statistically at par regarding fresh weight per plant at 30-day stages.

Similarly, the significantly lowest (8.70 g) fresh weight per plant was recorded with $W_{0,}$ W_2 (9.20 g), and W_3 (9.20 g) weed control methods, which were statistically at par and significantly higher as compared with W_0 and W1.

The interaction effect of fertility levels and weed control methods (FXW) was found to be non-significant.

At the 60-day stage, all the fertility levels were found to differ significantly from each other. The significantly lowest and highest (4.47 and 11.32 g) fresh weight per plant were recorded with F_0 and F_3 fertility levels, respectively.

The fresh weight per plant was significantly lowest and highest (7.55 and 11.11 g) with the W_0 and W_3 weed control methods, respectively. The W_1 and W_2 were statistically at par regarding fresh weight per plant.

The interaction effect of fertility levels and weed control methods (FXW) on fresh weight per plant was found to be significant at 60-day stages.

Clearly indicate that fresh weight per plant increased with each increase in fertility levels. The significantly highest and lowest (14.30 and 3.85 g) fresh weight per plant was recorded with F_3 W_3 and F_0 W_0 treatment combinations, respectively.

At the 90-day stage, the fresh weight per plant was found to increase significantly with each increase in fertility level. The significantly lowest and highest (5.16 and 12.19 g) fresh weight per plant were recorded with F_0 and F_3 fertility levels, respectively.

Similarly, the fresh weight per plant also increased significantly with weed control methods. The minimum and maximum (8.53 and 11.94 g) fresh weight per plant were recorded with W_0 and W3, respectively.

The interaction effect of fertility levels and weed control methods (FXW) was found to be significant at the 90-day stage, clearly indicating that fresh weight per plant increased with each increase in fertility level and weed control method. The significantly lowest and highest (4.46 and 13.86 g) fresh weight per plant were recorded with F_0 W_0 and F_3 W_3 treatment combinations, respectively.

At the harvest stage, the significantly lowest (21.58 g) fresh weight per plant was recorded with the F_0 fertility level, whereas the significantly highest (23.22 g) fresh weight per plant was recorded with the F_3 fertility level.

The weed control methods also have a significant effect on fresh weight per plant. The significantly lowest (28.41 g) fresh weight per plant was recorded with W_0 weed control methods, whereas the maximum (30.70 g) fresh weight per plant was recorded with W1, which was statistically at par with (30.68 g) W_3 weed control methods.

The interaction effect of fertility levels and weed control methods (FXW) on fresh weight per plant at the harvest stage was found. Non-significant.

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