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Effect of tillage, irrigation schedule and N-fertilization on barley the central zone of Uttar Pradesh

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Abstract
The study was carried out in the Department of Agronomy of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur U.P. India, during rabi season of 2013-14. The treatments comprised of viz. 2 tillage, 3 Irrigation schedule and 2 Nitrogen fertilization in 12 treatment combinations, viz. $T_1+IR_1+F_1$, $T_1+IR_1+F_2$, $T_1+IR_2+F_1$, $T_1+IR_2+F_2$, $T_1+IR_3+F_1$, $T_1+IR_3+F_2$, $T_2+IR_1+F_1$, $T_2+IR_1+F_2$, $T_2+IR_2+F_1$, $T_2+IR_2+F_2$, $T_2+IR_3+F_1$, $T_2+IR_3+F_2$. The tillage was tried in main plots, irrigation schedule and nitrogen fertilization in sub plots in split plot design with 3 replication. The crop raised with recommended package of practices other than treatments. The 1.0 IW/CPE ratio irrigation level was produced highest in respect to growth attributes, yield attributes, grain yield 42.67 q ha^{-1}, harvest index 38.73 percent, consumptive use 240.69 mm, water use efficiency 17.72 kg grain ha^{-1} mm, N content in grain 1.87 percent, N content in straw 0.33 percent, NUE 116.13 percent, net income 40899 Rs. ha^{-1} and benefit cost ratio 1.37, but reduced in 0.75 IW/CPE ratio and 0.5 IW/CPE ratio respectively.

Keywords: Barley, irrigation, tillage

Introduction
Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop of the world after wheat, rice and maize. In India it is popularly called "Jau" Its Sanskrit Name "Yav" is mentioned in Vedas. Its grains contain 8-10 percent protein and 74 percent carbohydrates besides minerals and vitamin B-complex, it thus forms a staple food, cattle feed, malt for manufacturing of beer and other liquor products (Singh *et al.* 2009). Barley is also known to contain water soluble fiber (beta glucans) and oil compound (tocotrienols) which are found to be effective in lowering cholesterol level of blood (Hales 1992). Its straw is also used for making hay and silage. This crop was grown on 6.71 lakhs hectares and recorded a production of 17.30 lakhs tonnes with an average yield of 2.58 t ha^{-1} in India during 2013-14 (Anonymous 2014). The major barley producing states in India are Rajasthan, UP, Haryana, MP and Punjab. In Uttar Pradesh it was grown on 1.56 lakhs hectares with a production of 4.50 lakhs tonnes with an average yield of 2.88 t ha^{-1} during 2013-14 (Anonymous 2014). Punjab ranked first in terms of productivity of barley during 2013-14. Due to its very hardy nature, barley can be successfully cultivated under adverse agro-climatic conditions. Barley is usually preferred crop by farmers over wheat under constrained environment (Mishra and Shivakumar 2002).
Under North Indian conditions, recommended sowing time of barley is from middle of October to middle of November (Anonymous 2014). Maximum, minimum and optimum temperatures for germination of barley are 38 to 40, 3.5 to 5 and 20 °C, respectively (Malik, 1980). These temperatures prevail from mid-October to end-November or early December in North India. The differences i and late sown crops may be attributed to the unfavorable temperature prevailing at different growth stages, such as low temperature at the time of germination which may delay crop emergence production of timely sown

Result and discussion
The consumptive use influences markedly due to IW/CPE ratios in crop season. Irrigation given at 1.0 IW/CPE ratio resulted in increase in moisture use than 0.5 IW/CPE ratios and 0.75 IW/CPE ratio considering total moisture use by the crop IR_3 resulted in 12.88 percent higher consumptive use tan IR_1 irrigation level of experimentation. However, the 151.20mm rains during Dec. to March month also effect on moisture use in IW/CPE ratio irrigation scheduled.
Inoculation of *Azotobacter* with RDF also caused markedly variation in total moisture use by crop. As such the maximum values were recorded due to F_2 levels. Application of RDF with *Azotobacter* augmented total consumptive use by 3.84 percent,

Table 1: Effects of Tillage, irrigation schedule and N- Fertilization on consumptive use and water use efficiency of barley during 2014

Treatments	Consumptive use of water (mm)	Water use efficiency
Tillage		
T_1	228.30	17.68
T_2	219.23	17.64
Irrigation schedule (IW/CPE ratio)		
IR_1	209.68	17.61
IR_2	220.93	17.65
IR_3	240.69	17.72
N- Fertilization		
F_1	219.38	17.64
F_2	228.15	17.67

Table 2: Effect of Tillage, irrigation schedule and N- Fertilization on different Plant growth factors

Treatment	Gross return (Rs. ha-1)	Cost of cultivation (Rs.ha-1)	Net return (Rs.ha-1)	B:C ratio
Tillage				
T_1	67340.50	29930.50	37410.00	1.25
	64797.83	29930.50	34867.33	1.16
SE(d)	392.21	----	344.65	0.008
CD	1687.67	----	1483.03	0.036
Irrigation scheduling (IW/CPE ratio)				
IR_1	62288.75	30475.50	31813.25	1.04
IR_2	65361.25	29658.00	35703.25	1.20
IR_3	70557.50	29658.00	40899.50	1.37
SE(d)	496.29	----	424.16	0.011
CD	1035.26	----	884.81	0.023
N- Fertilization				
F_1	64910.66	29699.00	35211.66	1.18
F_2	67227.66	30162.00	37065.66	1.22
SE(d)	405.22	----	346.33	0.009
CD	845.29	----	722.44	0.019
Interaction	NS	NS	NS	NS

It is presented from the data (Table 2) that IR_3 irrigation level recorded significantly higher gross return and net return compared from IR_1 and IR_2. However, IR_2 irrigation schedule showed in significant increase in gross and net return as well as benefit cost ratio from IR_1 level. But IR_3 irrigation schedule resulted in significant increase in benefit cost ratio compared from both level of irrigation IR_1 and IR_2 treatments. The maximum gross return of Rs. 70557.50/- was associated with IR_3 irrigation level, which was 8268.75/- and Rs. 5196.25/- higher than that of IR_1 and IR_2 irrigation level respectively. However, the maximum value of net returns of Rs. 40899.50/- was realized with IR_3 irrigation level compared to IR_1 and IR_2 respectively.

It is clear from the data that inoculation of *Azotobacter* with RDF level augmented gross return and highest value of 67227.66/- was associated with F_2 level. The data clearly indicated that net return increased with inoculation of *Azotobacter* in F_2 level followed by F_1 level. The maximum net return of 37065.66/- was recorded under F_2 level which was 5.00 percent higher than F_1 level.

Data regarding benefit cost ratio showed that increasing by the inoculation of *Azotobacter* with RDF level significantly enhanced the benefit cost ratio. The maximum B: C ratio value (1.22) was recorded in F_2 N- Fertilization followed by (1.18) F_1 levels.

Suggestion

1. The flat bed deep tillage promoted the plant population, plant height, dry weight, number of shoots running meter^{-1}, productive and unproductive tillers running meter^{-1}, all yield attributes, biological, grain and straw yield ha^{-1}.
2. Highest consumptive use was recorded with flat bed deep tillage than flatbed conventional tillage. The highest WUE and nitrogen use efficiency also was associated with flat bed deep tillage than flat bed conventional tillage.
3. Irrigation scheduling at 1.0 IW/CPE ratio enhanced growth and yield attributes, grain and straw yields over 0.75 and 0.5 IW/CPE ratios.
4. Water consumption, water use efficiency and N use efficiency also enhanced under Irrigation scheduling at 1.0 IW/CPE ratio in all treatments.
5. Significant improvement in growth and yield traits, grain and straw yields were recorded due to inoculation of Azotobacter with recommended dose of fertilizer (60, 40, 40 kg N, P_2O_5, K_2O) over RDF level.

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