"An Investigation into the Impacts of Preparatory Tillage and Nutrient Management on Barley Yield and Economic Viability in the Context of Water Stress Conditions"

ABSTRACT

A number of field tests were carried out at the Chandra Shekhar Azad University of Agriculture and Technology's Soil Conservation and Water Management Farm in Kanpur, Uttar Pradesh, during the successive rabi seasons of 2017–18 and 2018–19. The gangatic alluvial soil in the study area had a pH of 7.6, which was indicative of its light texture and moderate soil fertility. The study included three different treatments that included preparatory tillage techniques: T1 treatment was one cross plowing with a cultivator; T2 treatment was one disc harrow plowing followed by another cross plowing with a cultivator; and T3 treatment was one disc harrow plowing plus one rotavator pass.The experiment also looked into three different nutrient management strategies: N1, which involved applying 100% of the Recommended Dose of Fertilizers (RDF)—60 kg of N, 30 kg of P_2O_5, and 30 kg of K_2O—through chemical fertilizers; N2, which involved applying 75% of the RDF through chemical fertilizers along with 25% of Farm Yard Manure (FYM); and N3, which applied 50% of the RDF through chemical fertilizers along with 50% of FYM. In addition to applying 50% RDF through chemical fertilizers combined with 50% FYM, the results of the two-year experiment showed that planting barley crops in plots that received one disc harrow plowing and one rotavator pass yielded the maximum values across growth factors, yield attributes (such as grain yield q ha-1, straw yield q ha-1, biological yield q/ha,as well as harvest index), net return, gross return, and the barley benefit-to-cost ratio.This was noted in both years in a consistent manner. The next best results were seen with preparatory tillage, which involved using a cultivator to plough a single cross and applying chemical fertilizers to achieve 100% RDF (N1: 60 kg N ha-1 + 30 kg $P_2O_5ha^{-1}$ + 30 kg K_2Oha^{-1}).

Key words: fertilizers, cultivators, rotavators, and disc harrows.

INTRODUCTION:-

Usually sown in October and November and harvested in March or April, barley has consistently produced 1.6 to 1.8 million metric tons annually in India; in 2020 and 2019, the amount produced was 1,687 and 1,633 thousand tons, respectively. With an average yield per hectare of roughly 1,944 kilograms, the farming area has remained still despite this stability, ranging between 0.65 and 0.7 million hectares. Barley is cultivated extensively in Uttar Pradesh, Rajasthan, and Madhya Pradesh, accounting for 34%, 30%, and 12% of the total acreage, respectively. Together, these three states account for about 80% of the total area under cultivation. Although Uttar Pradesh has the most acres, barley production is the highest in the state because of its high yields; it accounts for 34% of total production, with Rajasthan and Madhya Pradesh following at 30% and 12%, respectively. Barley accounts for 7% of the world's total cereal production. With a 42% contribution, the European Union-27 (EU-27) is the leading producer, followed by Australia (5%), Canada (8%), Ukraine (8%), and Russia (15%). Barley is a winter crop grown in India that grows well in a range of agroclimatic zones and production systems. Notably, it provides life to areas that are 3000 meters overhead sea level, frequently serving as millions of people's main source of food, drink, and necessities. Compared to many other crops, barley grows best in well-drained soils and has a greater tolerance for soil salinity. Food barley is a resilient crop that is frequently grown in areas that are under stress due to frost, sporadic droughts, or soil erosion. Research has indicated that tillage techniques can considerably increase the yield of barley seeds by efficiently preserving soil moisture during periods of intermittent drought. To increase barley seed yield and water productivity, recommendations include using field bounding, deep plowing during the monsoon period, & straw covering at a rate of five tons per hectare. These techniques make use of in-situ moisture conservation techniques (Tapanarova, A. 2005).

Regar *et al*. (2009) conducted research that supported the efficiency of tillage techniques in preserving soil moisture during sporadic droughts, thereby increasing the yield of barley seeds. Their results support the use of field bounding, deep plowing in the monsoon, and five tons per hectare of straw mulching to increase barley seed yield and improve water productivity by preserving in-situ moisture.

Hordeum vulgare L., or barley in scientific parlance, is an important cereal crop during the rabi season, especially in dryland agriculture. Because of its resistance to drought, temperature swings, and other environmental stresses, it is a mainstay in areas with difficult agricultural conditions. Over centuries, barley varieties that thrive in low-yield environments with little agro-management have been shaped by together natural collection and human intervention.Barley malt is mostly used in the making of strong beverages, though a tiny portion is used in food products, mainly for flavor enhancement. Even though they don't strictly qualify as food, alcoholic beverages do add to nutrition, either in addition to or instead of meals (Titus, Jonathan H. and Del Moral, Roger (1998). Barley also contains water-soluble fiber (beta-glucans) and substances called tocotrienols that have been shown to lower blood cholesterol. Barley straw is used for making hay and silage, among other things. Its grains, which make up 8–10% protein and 74% carbohydrates, are rich in minerals and have a B-complex vitamin profile. This makes it an important part of many diets, including cattle feed and malt, which is used to make beer &additional alcoholic drinks. Civilized for above ten thousand years, this cereal is one of the earliest known domesticated crops. According to archeological discoveries, barley was first cultivated in Iran circa 8000 BC. Among the nutrients found in fertilizers, nitrogen stands out because it is the most absorbed and frequently the main factor limiting crop productivity. Its presence promotes fruit and seed development, causes fastdevelopment, increases leaves, and improves quality. While excessive nitrogen fertilizer rates may cause an excessive amount of nitrogen to be translocatedafterasexualquantities to the grain, resultant in a higher grain protein content, inadequate nitrogen levels can compromise quality (Tapanarova, 2005).

"Yield Maximization through Nutrient Management in Barley" was the title of a comprehensive field experiment carried out in the rabi season of 2022–23 at Rama University's agricultural farm in Kanpur, situated in central region of Uttar Pradesh. Ten different nutrient management strategies were used in the experiment, all of which were intended to maximize barley yield. T1 (control), T2 (recommended fertilizer dose; RDF 120:60:60 NPK kg ha-1), T3 (urea-based nitrogen plus 25% from farm yard manure; FYM), T4 (application of FYM at 10 tons per hectare), and T5 (RDF + ZnSO4 at 25 kg ha-1; phosphorus from diammonium phosphate; DAP) were among these treatments.To accurately assess the effectiveness of each treatment on barley yield maximization, the experimental design used three replications of a randomized block pattern. T6 (RDF + ZnSO4 at 25 kg ha-1, with P sourced from SSP), T7 (RDF by nitrogen obtained from Zinc-coated urea and P after SSP), T8 (75% RDF + Azotobacter + Phosphorus solublizing bacteria), T9 (RDF by N obtained from Neem coted Urea & P from SSP), and T10 (RDF through 50% N sinceNCU + 50% N from ZCU and P from SSP) were the treatments..

MATERIALS AND METHODS:

It appears that you have described field experiment carried out in the rabi season of 2022–23 at Rama University's agricultural farm in Kanpur, situated in central region of Uttar Pradesh. The gangatic alluvial soil used for the trial had a pH of 7.6, making it a light-textured soil by modest fertility. Rainfall in the area usually ranges since 800 to 850 mm on average per year. The experimental treatments consisted of preparatory tillage techniques: T1 was one cross plowing with a cultivator, T2 was one disc harrow plowing followed by another cross plowing with a cultivator, and T3 was one disc harrow plowing plus one rotavator pass.N1 - 100% Endorsed Amount of Fertilizers over chemical stimulant (60 Kg N ha-1 + 30 Kg P2O5 ha-1 + 30 Kg K2O ha-1), N2 - 75% RDF over chemical stimulant pooled by 25% FYM, and N3 - 50% RDF over chemical stimulant joint with 50% FYM were the three variations of nutritional management treatments. The experimental field had a sandy loam texture, was slightly calcareous, and had the following specific soil properties: wilting point at 6.2%, field capacity at 18.38%, water holding capacity at 29.7%, bulk density at 1.40 Mg m-3, particle density at 2.50 Mg m-3, O.C. - 0.32%, entire N at 0.033%, accessible phosphorus at 16.85 kg ha-1, accessible potash at 130.30 kg ha-1, EC at 0.34 dS m-1, bulk density at 1.40 Mg m-3, Particle density at 2.50 Mg m-3, and porosity at 43.97%.A number of factors were assessed: The grain/seed yield (q–1) is converted into q ha–1 by hand threshing and weighing the seed production since every plot. The term "straw yield" (q ha-1) refers to the amount of biomass produced overall for each plot, subtracted from the seed yield. Crops are harvested since the dry, net plot area and considered to determine the biological yield (q ha^{-1}), which is then expressed. A particular formula was used to calculate the harvest index (%), which shows how well CO_2 fixation and acclimatization are used.

It appears that you may have been explaining how these agricultural parameters were measured in the experimental plots.Tell me if there's a particular formula or calculation technique you need help with

$$\text{H.I. (\%)} = \text{Seed/grain yield (q ha}^{-1}\text{) / Biological yield (q ha}^{-1}\text{) x 100}$$

The gross arrival (Rs /ha) in economics is determined by multiplying the yield of grain, seed, and straw ha-1 by the current market prices for seed and straw. In order to calculate net return (Rs ha^{-1}), the relative costs of cultivation for each treatment were subtracted from the gross income of the consistent treatments. The proportion of gross profit to cultivation cost, or return invested, is known as the cost ratio.

RESULTS AND DISCUSSION:-

1. YIELD OF BARLEY CROP

The results of both years' statistical analyses of the effects of nutrient managementand preparatory tillage techniques on the grain, straw, and biological yields of the barley crop are shown in Table 1.

Plots subjected to T3, which involved 1 tillage with a disc plowtailed by 1 pass by a rotavator, appear to have produced the highest yields in terms of grain (26.52 & 28.18 q ha^{-1}), straw (36.55 & 38.41 q ha-1), and biological yield (62.34 & 66.60 q ha-1) among the various preparatory tillage methods evaluated. T2, which involved one cross-ploughing with a cultivator and one plowing with a disc harrow, followed closely behind and produced results that were likewise quite good.On the other hand, plots subjected to T1, which involved only one cross ploughing with a cultivator, produced the minimum straw (32.56 & 32.15 q /ha), yields in grain (25.25 & 25.86 q /ha), and biological produce (57.60 & 57.01 q /ha). This is consistent with findings reported in research by Brar, S.S., Kumar, S. and Bajwa, J.S.; (2002) and Morellet *et al.* (2011).

The impact of various preparatory tillage techniques on barley yields is demonstrated by these results, which also show that T3 (one disc harrow plowing plus one rotavator pass) and T2 (one disc harrow plowing plus one cross plowing with cultivator) outperform T1 (one cross plowing with cultivator) in terms of improving straw, grain, and biological yield in the designated experimental years.

Preparatory tillage, specifically T1 treatments involving one cross-ploughing with a cultivator, produced a higher harvest index for both years' results when compared to extra preliminary ploughing techniques. During the experimental year, the T3 treatments—one cross-plowing with a rotavator and one disc harrow—had the lowest harvest index.

Out of all the nutrient management treatments, the plots with the highest yields of barley (q/ ha) (27.14 & 28.33), biological yield (63.49 & 67.64q/ ha) and straw yield (36.72 & 39.30q/ ha), were those where N3) 50% of the recommended fertilizer dose was ploughed with 50% farm yard manure (FYM) and then N1) was applied.The minimum grain yield (24.39 & 25.21), straw yield (q ha-1) (31.78 & 32.09), and biological yield (q ha-1) (56.19 & 57.30) of barley observed under treatment N1- 100% in 2020-21 & 2021-

22appreciated. However, the fertilizer dose was 75% through chemical fertilizer with 25% farm yard manure. The second-year harvest index under nutrient management treatments, namely N1 treatments—100% RDF (60 kg N + 30 kg P2O5 + 30 kg K2O ha-1) (dose through chemical fertilizer) (44.03%)—recognized its expressively maximum above all other nutrients managing practices during 2020-21. The highest harvest index (%) under nutrient management treatments, namely N2 treatments—75% fertilizer dose through chemical fertilizer with 25% farm yard manure (43.26%) during 2017–18.Consequently, the lowest H.I. over N3 treatments was 50% FYM (farm yard manure) + 50% RDF (chemical fertilizer) (42.85 & 41.98%) in both years. (Eskandari & Heimat, 2006).

ECONOMICS OF BARLEY

The data in Table 2 clearly shows that the preparatory tillage treatment (T3) one ploughing with a disc harrow and one pass with a rotavator better earned gross return (Rs. 52821 and 59324), net return (Rs. 23114 & 26717), and was followed by treatment T2 (one ploughing with a disc harrow + one cross ploughing with cultivator), which earned Rs. (50738 and 56540), net return (Rs. 20735 & 23995), while the minimum net return (Rs. 20210 & 19950) ,gross return of Rs. 49301 & 51557), was calculated under treatment T1 (One cross plowing with cultivator) during 2017–18 and 2018–19, respectively.

Applying nutrient-N1) 50% RDF+50% FYM resulted in better production and earned gross returns of Rs. 53630 and 59680, net returns of Rs. 22892&26681). Treatment T2 (one ploughing with a disc harrow + one cross ploughing with a cultivator) earned Rs. (51383 and 55660), net returns of Rs. 21611&23330, while treatment T1 (one cross ploughing with a cultivator) calculated minimum gross returns of Rs. 47848&52081), net returns of Rs. 19555&20652, respectively.

Benefit: Cost ratio was found to be lowest in the first year (1:1.62) unedr T1 treatments—one cross plowing with cultivator during 2018–19—and to be maximum in the 1st year (1.81) under T3 treatments—one plowing with disc harrow + one pass with rotavator.

Summary and Conclusion:-

The experiment showed that barley yields were significantly impacted by various preparatory tillage techniques. T3 (one ploughing with disc harrow + one pass with rotavator) produced the maximum straw yield (36.55 & 38.41 q ha-1), grain yield (26.52 & 28.18 q ha-1), and biological yield (62.34 & 66.60 q ha-1). T2 (one ploughing with disc harrow + one cross ploughing with cultivator) produced the next-highest grain yield (25.74 & 27.17 q ha-1), straw yield (34.25 &36.06 q ha-1), and biological yield (59.91 & 63.23 q/ha). On the other hand, during the experimental years, the lowest yields were recorded with T1 (1 cross plough with cultivator), which produced grain yields of 25.25 & 25.86 q ha-1, straw yields of 32.56 & 32.15 q ha-1, and biological yields of 57.60 & 57.01 q ha-1.

The present study highlights the significant influence of different tillage performs on barley production, although some research has indicated that no-tillage methods may not increase crop yields significantly. Comparing these results to no-tillage methods reported in other studies, they emphasize the critical part of preliminary tillage methods, particularly favoring T3 and T2, in improving barley yields. (Massek & Novak, 2018; Meneveux *et al*., 2006).Feiza, V.; Baigys, G.; D. Feizieneas well as Kutra, G. (2006).

The study's conclusions demonstrated the significant effects of different nutrient management strategies on barley yields.The nutrient management practices involving N3 (50% RDF + 50% FYM) produced the maximum straw yield (36.30 & 39.72 q ha-1), grain yield (27.14 & 28.33 q ha-1),and biological yield (63.49 & 67.64 q/ ha). N2 (75% RDF + 25% FYM) produced grain yield (25.98 & 26.66 q ha-1), straw yield (34.86 & 35.23 q ha-1), and biological yield (60.15 & 62.90 q ha-1). Conversely, during the experimental years, the lowest production were observed with N1 using the RDF; these yields included grain (24.39 & 25.21 q ha-1), straw (31.78 & 32.65 q ha-1), and biological (56.19 & 57.30 q ha-1). This agrees with or differs from research by Sharma, R. P., Suri, V. K., and Dinka, T.B. *et. al*. (2018) and Datt, N., N. (2001), signifying the variability of outcomes across different research investigations.

The T3 treatment—one disc harrow ploughing and one rotavator pass in preparatory tillage operation—recorded the highestt gross return (Rs/ ha 52821.33 & 59324.00) and net return (Rs /ha 23114 & 26717.78) of barley during 2017–18 and 2018–19. Barley's lowest gross return (Rs. 49301.44 & 51557.30) and net arrival (Rs/ ha20210 & 19950) were recorded during the experimental year in the preparatory tillage operation, which involved 1cross-ploughby a cultivator. Maximal advantage: the cost ratio was obtained with preliminary tillage applied at T3 treatment: one disc harrow ploughing plus one rotavator pass (1.76:1.81) in 2017–18, then one cross ploughing with a cultivator (1:1.69) in 2017–18, and at T2 treatment: one disc harrow plowing plus one cross plowing with a cultivator (1:1.73) in 2021-22. Colleagues and Dhiman Mukherjee (2015) B. C. Reddy (2018),.

The maximum gross return (Rs/ha 53629.88 & 59680.33) and net return (Rs ha^{-1} 22892.3 & 26681.00) of barley under nutrient management treatment, which applied nutrients through chemical fertilizer and farm yard manure, were recorded in N3 treatment—50% RDF + 50% FYM—in nutrient management practices significantly during 2017–18 and 2018–19. The lowest gross return (Rs. 47848.44 & 52081.20), net return (Rs /ha19555 & 20652) of barley was recorded in nutrient management practices given at N1 treatment—100% RDF—during the experimental year. The best benefit-to-cost ratio was achieved in 2017–18 when nutrient management practices were applied at 50% RDF + 50% FYM (1.74:1.80). In contrast, the experiment year's net return of barley was significantly lower when nutrient management practices were applied at 100% RDF (Rs/ha 1.67: 1.65). Habib *et al*. (2016), Katiyar and Katiyar (2002) and K. Priyanka *et a*l. (2019).

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Table 1: Effect of preparatory tillage and Nutrient managements practices ongrain yield, straw yield, biological yieldand harvest index (%)of barley

Treatments	GRAIN YIELD		STRAW YIELD		BIOLOGICAL YIELD		Harvest index (%)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Preparatory Tillage (T)								
T_1	25.25	25.86	32.56	32.15	57.60	57.01	43.86	43.69
T_2	25.74	27.17	34.25	35.96	59.91	63.23	42.78	43.07
T_3	26.52	28.18	36.55	38.41	62.34	66.60	42.67	42.42
SE (d)	0.45	0.52	0.98	1.15	1.19	1.42	0.27	0.32
CD (P=0.05)	0.95	1.10	2.09	2.47	2.53	3.94	0.57	0.68
Nutrient Management (N)								
N_1	24.39	25.21	31.78	32.09	56.19	57.30	43.20	44.03
N_2	25.98	26.66	34.86	35.23	60.15	62.90	43.26	43.17
N_3	27.14	28.33	36.72	39.30	63.49	67.64	42.85	41.98
SE (d)	0.450	0.52	0.98	1.16	1.19	1.42	027	0.32
CD (P=0.05)	0.954	1.10	2.09	2.47	2.53	3.94	N.S.	0.68

Table2: Effect of preparatory tillage and Nutrient management practices on Gross return (Rs ha^{-1}), Net return and B: C Ratio of barley.

S.N.	Treatments	Gross return (Rs ha^{-1})		Net return		B: C Ratio	
		2020-21	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**
1.	**preparatory tillage**						
	T_1	49301	51557	20210	19950	1:1.68	1:1.62
	T_2	50738	56540	20735	23995	1:1.68	1:1.73
	T_3	52821	59324	23114	26717	1:1.76	1:1.81
	SE (d)	1176.70	451.30	435.20	378.32	.02	0.01
	CD (P=0.05)	2494.61	956.76	922.63	802.04	NS	0.04
2.	**nutrient management**						
	N_1	47848	52081	19555	20652	1:1.67	1:1.65
	N_2	51383	55660	21611	23330	1:1.72	1:1.71
	N_3	53630	59680	22892	26681	1:1.73	1:1.80
	SE (d)	1176.70	451.30	435.20	378.32	.02	0.01
	CD (P=0.05)	2494.61	956.76	922.63	802.04	.05	0.04