Impact of cutting dates and nitrogen application on grains yield and yield components of two six-row barley at two locations of Sulaimani District

Maki Mohammed Ahmad Assistant Lecturer
Kamil Mahmood Mustafa Lecturer
Sanarya Rafiq Muhammed Assistant professor
Almas Galal M.Rashed Assistant Lecturer
Crop Science Department College of Agriculture Science University of Sulaimani
Email: maki.ahmad@univsul.edu.iq

Abstract :

A field experiment was conducted under rainfed conduction of Bacrajo and Bazian locations (Iraq-Kurdustan region) during 2015-2016 cropping season. The experiment consisted combinations of four cutting schedules (no cut, 80, 105, and 130 Days after sowing DAS), two barley varieties (Ibba-99 and Local variety) and two Fertilizer levels (N 40 and 80 kg .h^{-1}). These 16 treatment combinations were evaluated under factorial randomized block design (RCBD) with three replications. Results revealed that application of no cut, Ibba-99 variety and N 80 kg .ha^{-1} fertilizer as alone or in combinations significantly (P 0.05) increased almost all growth parameters, in most cases led to significant (P 0.05) increases number of spike $m^{-2,}$ number of grains $spike^{-1}$, 1000-grain weight, Harvest Index (HI), and gave the highest biological yield and grain yield at the two locations. Cutting systems, varieties and N levels as alone or in all possible combinations (two and three-way interaction) had significant differences (P 0.05) effects on grain yield. The highest grain yield for (C_0, Ibaa-99, N 80), (C_0 x Ibaa-99), (C_0 x N 80), (Local variety x N 80) and (C_0 x Ibaa-99 x N 80) were 4.351 2.447, 2.509, 4.884, 4.782, 2.523 and 5.127 t ha^{-1}, respectively at Bakrajo location while at Bazyan location for (C_0, Ibaa-99), (N 80, C_0 x Local variety), (C_0 x N 80 Local variety x N 80) and (No cut(C_0) x Local variety x N 80) were 5.311, 3.814, 5.817, 5.551, 3.895, 3.938 and 6.216 tons ha^{-1}, respectively. The best grain yield for binary purpose barley at three-way combinations with (C_1 x Local var x N 80) were (4.043 and 5.770) t .ha^{-1} at Bakrajo and Bazyan locations, respectively. For that, application of (C_0 x Ibaa-99 x N 80) and (C_0 x Local variety x N 80) combinations at Bakrajo and Bazyan locations, respectively may be the best combination to achieve high grain in quantity, while (C_1 x Local variety x N 80) at the two locations for binary purpose barley may be the best option to achieve desired grains yield and forage yield in quantity under guaranteed rained Iraq-Kurdustan region.

Key Words: Barley, Varieties, cutting dates, N fertilizer, binary purpose

Introduction:

Barley (*Hordeum vulgare* L.) is major cereal in many dry areas regions of the world, also is a useful as well as valuable crop because it is used as human food, industrial and feed crop for domestic animals. In recent past, Iraq-Kurdustan region has made suffers in achieving self-sufficiency in grain production. Despite elevating productivity, land degradation, climatic variation and change are other challenges for more

production (26). However, livestock forage production is limited in Iraq. Barley with high total biomass be in possession, thus the farmers of our region utilized green barley fodder as feed for livestock or Milking animals. Because of it big total biomass and drought tolerance nature, there has been an accretion interest in investing barley as a dual purpose cereal which can take permission for forage production in onset season as well as the grain yield later on (37). Cutting plant's aerial part (heads) to limit grain yield in cereal crops, as result of leaf area limitations leading to tiller senescence during reproduction stage (34). Hama et al (12) reported that there were significant interaction between six genotypes and two cutting treatments on all yields and yield components traits with the exception of No. of Spike m^{-2}, 1000- grain weight and average spike weight. The highest number was exhibited by the combination of genotype (ATACO-) and non-cutting treatment in most traits in 2013-2014 seasons under Qlyasan-Sulaiman condition. Appropriate high yielding cultivar, cutting schedules and mineral fertilization are beholden to be most important precondition to obtain the best green fodder as well as grain yield (35). Shafi et al, (30) observed significant ($p<0.05$) differences in number of fertile tiller . m^{-2} number of grains . $spike^{-1}$, 1000 grain weight, harvest index, biological yield and grains yield, due to different levels of N and cultivars. In this context, the objective of this research was to determine the effects of frequent cutting aerial parts, nitrogen fertilization and cultivars in grain yield and its components of binary-purpose barley crops under guaranteed rained conditions in Iraq-Kurdustan region.

Materials and Methods:

The experiment was conducted at two locations of Sulaimani governorate, first was at Bakrajo (College of Agricultural Sciences-University of Sulaimani located (Latitude: 35˚ 33′; N, Longitude 45˚ 27′; E, at altitude of approximately 830 m) and the second was at Bazian location, which is situated 22.8 Km Southwestern of Sulaimani city with 814 m altitude above sea level during the 2015/2016 cropping seasons. The experiment consisted of 16 treatment combinations comprising two varieties (Ibba-99 dual purpose and Local variety), four cutting schedules (No Cut (C_0), Cut 80 days after sowing as $Cut_1(C_1)$ Cut 105 days after sowing as $Cut_2(C_2)$ and Cut 130 days after sowing as $Cut_3(C_3)$], dated on 4 February, 1 March and 25 March respectively, with two fertilizer levels of nitrogen viscount,(40 kg and 80 kg $.ha^{-1}$) as urea (46.6% N) that applied at the above mentioned levels by two doses, first part was applied in sowing date and the second part was applied after 30 days of sowing. The phosphorus at the rate of (80 kg P_2O_5 ha^{-1}) was applied as triple super phosphate as a basal dose before sowing. The experiment was laid out in split-split plot layout arrangement with randomized complete block design (RCBD) with three replications, Main plots were two levels of nitrogen and sub plots were two Barley varieties while sub-sub plots were different cutting times. Total precipitation and average temperature and the major soil characteristics were showed in the tables 1a and 1b, respectively. The crop was sown manually on 15 and 16 November, 2014. The distance between rows 25 cm and using seed rates (140 $kg.ha^{-1}$) The binary purpose barley crop was harvested first for green fodder at 80 days after sowing, 105 days after sowing and 130

days after sowing per treatment. After harvest of green fodder, the crop was raised for grain purpose. The data was recorded on different traits; the number of grains spike^{-1}; five spikes from each plot were selected and threshed. The number of grains were counted and then averaged. The data of number of spike m^{-2} was observed physically and counted by two middle lines; that equaled to one m^2. 1000-grain weight was recorded by taking random samples from threshed grains of

Table 1a: Some physical and chemical properties of soil analysis at experimental sites during 2014-2015

Soil Properties		Soil samples Bakrajo	Soil samples Bazian
Sand (%)		3.98	6.31
Silt (%)		47.48	52.37
Clay (%)		48.74	41.32
Textural class (%)		Silty Clay	Silty Clay
E.C (dS.m)		0.18	0.16
PH		7.80	8.05
O.M (%)		1.66	1.53
Total N (%)		0.10	0.13
Available Phosphate (ppm)		9.612	7.443
CaCO3 (%)		23	19.5
Soluble Cations & Anions Meq / L	Ca^{2+}	1.6	1.6
	Mg^{2+}	3.6	2.1
	K+	0.125	0.051
	Na+	0.091	0.186
	CO_3^{-2}	2.5	0.6
	HCO_3^{-2}	1.5	0.9
	Cl-	0.8	0.9

each plot, computed and weighted by electric balance. The biological yield, middle lines were harvested, dried in sun for seven days and then weighted by digital balance. The yield was then calculated to ton . ha^{-1}. The barley grains yield after threshing were collected and weighted to record grain yield in kg m^{-2}. Then it was converted to ton ha-1. The harvest index was determined as the ratio of grain yield kg .ha^{-1} to biological yield t .ha^{-1}. All data are presented as mean values of three replicates. The data were statistically analyzed according to the methods of analysis of variance as a general test and combined analysis conducted The significance of differences among means was compared by using Least Significant Difference (LSD) test at significant level of (0.05) (5)

Table 1b: Average monthly and seasonal meteorological data during 2014-2015 for the two locations.

Month	*Bakrajo**				*Bazian **			
	Min. Temp.(c°)	Max. Temp.(c°)	Avg. Temp.(c°)	Rainfall (mm)	Min. Temp.(c°)	Max. Temp.(c°)	Avg. Temp.(c°)	Rainfall (mm)
October	9.1	34.4	20.4	48.8	9.39	27.33	18.36	71.1
November	2.9	22.2	12.0	130.4	3.23	18.82	11.02	136.9
December	2.2	17.9	9.2	115.3	0.82	13.36	7.09	70.3
January	-3.2	16.6	6.8	99.6	-2.8	13.68	5.44	70.7
February	0.2	19.8	8.8	67.6	0.23	16.32	8.27	49.5
March	3.2	22	12.1	101.8	1.23	18.61	9.92	62.2
April	5.0	32.2	16.7	23.5	3.84	26.52	15.18	4.5
May	11.2	36.9	24.6	17.2	10.68	34.32	22.5	11
June	22.1	38.1	30.1	0.0	16.13	41.77	28.95	0.00
Total rain-fall				604.2				476.2

Table 2:Mean square of ANOVA's of number of spike m^{-2}, number of grains $spike^{-1}$, 1000-grain weight, HI, biological yield and grain yield in barley at two locations.

S.O.V	df	Spike m^{-2}		Grains $spike^{-1}$		1000 grain weight		HI		Biological yield		Grain yield	
		Bkj	Baz	Bkj	Baz	Bkj	Baz	Bkj	Baz	Bkj	Baz	Bkj	Baz
N	1	4144 *	1789 ns	11.5 ns	0.02 ns	83.1 *	0.25 ns	0.003 ns	0.001 ns	5.42 *	0.76 ns	0.58 **	0.81 *
E(a)	2	43.2	760	1.8	1.3	1.6	0.9	0.001	0.002	0.25	3.37	0.01	0.04
V	1	3960 **	136.7 ns	4.78 ns	595.1 **	9.66 **	33.3 **	0.006 **	0.006 *	0.01 ns	4.84 ns	0.11 *	0.12 ns
N x V	1	52140 **	5919 **	3.09 ns	63.0 **	6.19 **	4.94 *	0.000 ns	0.000 ns	0.18 ns	10.8 ns	0.18 *	0.42 *
E(b)	4	59.9	118	4.57	1.83	0.28	0.48	0.000	0.000	0.094	2.18	0.01	0.04
C	3	153956 **	298606 **	2392 **	2530 **	223 **	506 **	0.13 **	0.40 **	240.1 **	187 **	43.8 **	68.4 **
N x C	3	5308 **	972 **	155 **	45.4 **	28.0 **	3.17 **	0.004 **	0.005 **	1.22 **	1.76 ns	0.03 ns	1.35 **
V x C	3	16399 **	1652 **	42.86 **	18.57 **	15.3 **	8.63 **	0.007 **	0.005 **	1.66 **	1.87 ns	0.98 **	0.57 **
NxVxC	3	3943 **	4148 **	21.02 **	28.24 **	7.94 **	3.48 **	0.015 **	0.003 **	3.38 **	18.4 **	0.97 **	0.45 **
E(c)	24	64.3	202.9	2.29	0.65	0.32	0.30	0.000	0.000	0.137	3.05	0.01	0.03
Total	47	126.4											

Bakrajo (Bkj) Bazyan (Baz)

Results and Discussion:

According to the results in ANOVA table, the effect of three qualitative factors: levels of nitrogen (N), variety (V) and cutting time (C) on the dependent variables of the yield and its components showed that N levels had a significant effect ($P \leq 0.01$) on grain yield and ($P \leq 0.05$) on spike m^2, 1000-grain weight and biological yield at Bakrajo location and ($P \leq 0.05$) on grain yield at Bazyan location, while V had a significant effect($P \leq 0.01$) on spike . m^2, 1000 grain weight and HI at Bakrajo location and grains . $spike^{-1}$and1000 grain weight at Bazyan location and ($P \leq 0.05$) on HI and grain yield at Bakrajo and Bazyan locations, respectively. Cutting time had a signif-

icant effect ($P \leq 0.01$) on all traits at the two locations. Therefore, our results refer to improve grain yield, number of spike.m^{-2}, number of grain spike^{-1}, 1000-grain weight, HI and biological yield

biological yield performance. However N x V interaction were significant differences ($P \leq 0.01$) on spike m^{-2} and 1000-grain weight and ($P \leq 0.05$) grains yield at Bakrajo location, while ($P \leq 0.01$) on spike m^{-2} grains spike^{-1}and ($P \leq 0.05$) 1000-grain weight and grain yield at Bazyan. In addition, there were a highly significant for (N x C), (V x C) and (N x V x C) interactions ($P \leq 0.01$) for all traits at the two locations with except of biological yield and grain yield for (N x C) at Bazyan and Bakrajo locations respectively and for (V x C) for biological yield at Bazyan. This means that not all cutting dates responded the same to the two varieties or N fertilization levels of barley (Table: 2), this results consistent with many researchers (20, 23). Singh and Uttam (33) in experiments on barley stated as expected, the main factors N and variety. Were significantly affected either on the yield grain and its components, but the interactions were less effect.

Spike m^{-2}:

Number spike. m^{-2} is the most important barley traits, which guarantees higher yield. Effects cut dates, all interactions at the two locations and N and varieties at Bakrajo location were significant on spike. m^{-2}, while none of the N or varieties were significant at Bazyan location (Table 3). Control (no cut=C_0) gave the highest spike. m^{-2} reached to 327.92 and 424.08 spike , while (C_3) gave the lowest spike m^{-2} 70.08 and 65.33 for Bakrajo and Bazyan locations, respectively. Ibba-99 variety gave more spike. m^{-2} reached to (218.67) as compared to Local variety producing (200.500) spikes m^{-2} at Bakrajo location. Low N (40 kg .ha^{-1}) gave minimum spike. m^{-2} (200.29). Each increment of N increased number of spike m^{-1} 200.29 and maximum (No of spike. m^{-2}) (218.88) was recorded at 80 kg N ha^{-1} at Bakrajo location, however, it was not significantly different in spikes produced at Bazyan location. Similar results were reported by many researchers such as (19, 6 and 30) who observed that nitrogen application significantly affected productive tillers. m^{-2}.The (N x V) interaction showed that.

Table 3: Spike m^{-2} of six-row barley as affected by cutting dates, varieties and nitrogen levels.

Bakrajo						
Nitrogen Kg. ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut (C_0)	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	376.000 a	310.000 d	286.333 e	71.333 j	260.917 a
40	Local	334.667 c	247.333 f	97.000i	28.333 k	176.833c
80	Ibba-99	245.667 f	188.667 g	175.333 g	96.000i	176.417 c
80	Local	355.333 b	330.667 c	126.000 h	84.667i	224.167b
40		300.500 b	259.667 d	150.667 f	90.333 g	200.292 b
80		355.333 a	278.667 c	191.667 e	49.833 h	218.875 a
	Ibba-99	310.833 b	249.333d	230.833 e	83.667g	218.667 a
	Local	345.000a	289.000c	111.500f	56.500 h	200.500 b
Means		327.917a	269.167 b	171.167 c	70.083 d	

Bazyan						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut (C_0)	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	494.000 a	337.333 f	337.000 f	87.667 g	314.000 a
40	Local	372.333 cd	390.667 c	333.000 f	57.667 h	288.417bc
80	Ibba-99	343.667ef	381.333 cd	335.000 f	58.333gh	279.583 c
80	Local	430.333 b	343.333ef	362.333 de	57.667 h	298.417 b
40		442.333 a	354.833 c	335.000 d	72.667 e	301.208
80		405.833 b	353.000 c	339.167 cd	58.000 e	289.000
	Ibba-99	437.667 a	340.500 d	336.000 d	73.000 e	296.792
	Local	410.500 b	367.333 c	338.167 d	57.667 e	293.417
Means		424.083 a	353.917 b	337.083 c	65.333 d	

Bakrajo: LSD (0.05) for N= 8.159, V=6.203, C=6.755, N×V=8.772, N×C=9.553, V×C=9.553, N×V×C=13.511

***Bazyan: LSD (0.05) for C= 12.001, N×V= 12.331, N×C= 16.972, V×C= 16.972, N×V×C= 24.003**

Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.*

Maximum spike. m^{-2} (260.98, 314.00) were obtained from Ibba-99 variety receiving 40 kg N ha^{-1}, whereas lowest number of 176.42 and 279.58 spike. m^{-2} were produced by the interaction of Ibba-99 receiving 80 N.

kg. ha^{-1} at Bakrajo and Bazyan locations, respectively. Shafi et al., (30) pointed that varieties, nitrogen levels and their interactions had significantly ($p>0.05$) affected spike. m^{-2}. In the (N x C) interaction maximum spike. m^{-2} of 355.33 and 442.33 were obtained from interaction of 80 and 40 kg- N. ha^{-1} with no cut, while lowest values (49.83, 58.00) were obtained from 80 kg N and cut (C_3) for Bakrajo and Bazyan locations, respectively. Similar results were also reported by (1) who observed that spikes. m^{-2} of wheat significantly increased with fertilizer-N treatments, while the cutting stress significantly decreased spike. m^{-2} with significant (C x N) effect. Niazkhani et al., (24) observed not significant (C x N) effect in triticale. In the (V x C) interaction maximum spike. m^{-2} reached to 345.00 and 437.67 spikes were obtained from interaction of Local and Ibba-99 with no cut, while lowest values (56.50, 57.67) were obtained from Local variety with (C_3) for Bakrajo and Bazyan locations,

respectively. The (N x V x C) interaction revealed that maximum spike m^{-2} reached to 376.00 and 494.00 were recorded from (N1×V1 × C3), whereas the lowest values of 84.66 and 57.67 were recorded at 80 kg $N.ha^{-1}$ x Local variety (C_3) Bakrajo and Bazyan locations, respectively.(Table 3)

Grains spike^{-1}:

The grains spike^{-1} plays a pivotal role in grain yield (8). Effects, (V x C), (N x C), and (N x V x C) interaction were significant on grains spike^{-1} at the two locations, while the effects of V and (N x V) interaction were significant at Bazyan location only.

Table 4:Grains spike^{-1} of six-row barley as affected by cutting dates, varieties and nitro gen levels.

Bakrajo						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	51.110 b	50.443bc	52.003 b	16.443 k	42.500
40	Local	51.447 b	52.000 b	42.553 e	19.443 j	41.361
80	Ibba-99	55.830 a	47.557 d	38.000 f	22.670i	41.014
80	Local	51.890 b	48.333 cd	36.833 g	26.503 h	40.890
40		51.278 b	51.222 b	47.278 c	17.943 f	41.930
80		53.860 a	47.945 c	37.417 d	24.587 e	40.952
		53.470 a	49.000 c	45.002 d	19.557 g	41.757
	Local	51.668ab	50.167bc	39.693 e	22.973 f	41.125
Means		52.569 a	49.583 b	42.348 c	21.265 d	

Bazyan						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	60.000 a	51.333 b	45.333 d	19.667 j	44.083 a
40	Local	50.667bc	41.000 f	31.000 h	16.333 k	34.750 d
80	Ibba-99	49.667 c	50.000bc	43.667 e	24.000i	41.833 b
80	Local	49.667 c	44.000 de	38.000 g	16.667 k	37.083 c
40		55.333 a	46.167 c	38.167 e	18.000 g	39.417
80		49.667 b	47.000 c	40.833 d	20.333 f	39.458
	Ibba-99	54.833 a	50.667 b	44.500 c	21.833 f	42.958 a
	Local	50.167 b	42.500 d	34.500 e	16.500 g	35.917 b
Means		52.500 a	46.583 b	39.500 c	19.167 d	

***Bakrajo: LSD $_{(0.05)}$ for C=1.275, N×C=1.803, V×C=1.803, N×V×C=2.549**

***Bazyan: LSD $_{(0.05)}$ for V=1.085, C=0.677, N×V=1.535, N×C= 0.958, V×C= 0.958, N×V×C= 1.354**

However the effect of N fertilization was not significant at the two locations for this trait (Table 4).

Control (no cut=C_0**)** gave the highest grains spike^{-1} reached to 52.569 and 52.500, while (C_3) produced the lowest grains spike^{-1} 21.265 and 19.167 for Bakrajo and Bazyan locations, respectively. The decrease in the number of grains spike^{-1} may be attributed to the reduction that occurred in the number of spikelets spike^{-1} of the plants cut. The results of (7, 10) are in line with our findings as treatments without cutting yielded maximum grains.spike^{-1}. Ibba-99 variety produced more grains spike^{-1}

(42.96) as compared Local variety producing 35.92 grains. spike^{-1} at Bazyan location. The (N x V) interaction showed that maximum grains spike^{-1} (44.08) were obtained from Ibba-99 variety receiving 40 kg N. ha^{-1}, whereas lowest number of 37.08 grains. spike^{-1} were produced by the interaction of Local variety receiving 80 N kg ha^{-1} at Bazyan location, however, there were not significant differences for this interaction at Bakrajo location. Shafi et al., (30) reported that varieties, nitrogen levels and their interactions had significantly ($p>0.05$) affected grains. spike^{-1}. In the (N x C) interaction maximum grains spike^{-1} of 53.86and 55.33 were obtained from interaction of 80 and 40 kg N ha^{-1} with no cut, while lowest values (17.94, 18.00) were obtained from 40 kg N ha^{-1} and cut 130 days after sowing (C_3) for Bakrajo and Bazyan locations, respectively. Our results are in line with the findings (1) who observed that grains spike^{-1} of wheat significantly increased with fertilizer-N treatments, while the cutting stress significantly decreased grains.spike^{-1} with insignificant (C x N) effect. Niazkhani et al, (24) observed significant effect of C and (C x N) interaction in triticale. Shorter life cycle of crop might be the possible reasons for lesser grains in cutting treatments compared to no cut plots. In the (V x C) interaction maximum grains spike^{-1} reached to 53.47 and 54.83 spike were obtained from interaction of Ibba-99 and no cut, while lowest values (19.56, 16.50) were obtained from Ibba-99 and Local variety with cut 130 days after sowing (C_3) for Bakrajo and Bazyan locations, respectively. The (N x V x C) interaction revealed that maximum grains. spike^{-1} of 55.83 and 60.00 were recorded from 80 kg N. ha^{-1} x Ibba-99 with no cut and 40 kg N.ha^{-1} x Ibba-99 with no cut, whereas the lowest values of 16.44 and 16.33 were recorded at 40 kg N. ha^{-1} x Ibba-99 cut 130 days after sowing (C_3) and 40 kg N. ha^{-1} x Local variety cut 130 days after sowing for Bakrajo and Bazyan locations, respectively.

1000 grain weight (g):

Thousand grains weight is one of the most important yield components. It is influenced by both genetic and environmental factors and positive correlation coefficients were reported between grain yield and 1000-grain weight of barley (9). Effects N, variety, cut and all interactions at the two locations were significant on 1000-grains weight (Table 5). Control (no cut=C_0) produced the highest 1000-grains weight (g) 44.574 and 47.059, while cut 130 days after sowing (C_3) produced the lowest 1000-grains weight (g) 34.488 and 33.202 for Bakrajo and Bazyan locations, respectively. This may be due to that cutting further increased the vegetative growth period as in non-cut. Our results are in line with (7).However (21) also reported that barley no cutting or 50 days after sawing produced higher 1000-grain than forage cutting at 60 days after sawing. Ibba-99 variety produced more 1000-grains weight (g) (40.59, 43.721) as compared to Local variety producing 39.692 and 42.054 1000-grains weight (g) at Bakrajo and Bazyan locations, respectively. Low N (40 kg.ha^{-1}) produced minimum 1000-grains weight (38.825). Each increment of N increased 38.825 and maximum yield (41.456) was recorded at 80 kg N ha^{-1} at Bakrajo location, however, it was not significantly different from 1000-grains weight produced at Bazyan location. They further detected that application of nitrogen fertilizer significantly increased thousand grains weight (14, 25 and 16) in binary purpose wheat. But Hadi et

al., (11b) findings are against these results as increase in N. levels decreased the 1000 seeds we

Table 5: 1000 grains weight (g) of six-row barley as affected by cutting dates, varieties and nitrogen levels at two locations.

Bakrajo						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	44.893ab	44.237b	45.413a	34.513f	42.264 a
40	Local	43.627b	41.247c	40.087d	37.633e	40.648 b
80	Ibba-99	44.883ab	40.543d	37.387e	32.847g	38.915 c
80	Local	44.893ab	42.130c	34.960f	32.960g	38.736 c
40		44.888 a	41.337 c	36.173 d	32.903 e	38.825 b
80		44.260 a	42.742 b	42.750 b	36.073 d	41.456 a
	Ibba-99	44.888 a	42.390 b	41.400 c	33.680 f	40.590 a
	Local	44.260 a	41.688c	37.523 d	35.297 e	39.692 b
Means		44.574 a	42.039 b	39.462 c	34.488 d	

Bazyan						
Nitrogen Kg ha^{-1} V	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	46.657ab	46.367 b	46.723ab	36.707 e	44.113 a
40	Local	47.547 a	45.113 c	43.293 d	31.267 g	41.805 c
80	Ibba-99	46.953ab	46.593 b	46.667ab	33.100 f	43.328 b
80	Local	47.080ab	45.333 c	45.067 c	31.733 g	42.303 c
40		47.102 a	45.740 b	45.008 c	33.987 d	42.959
80		47.017 a	45.963 b	45.867 b	32.417 e	42.816
	Ibba-99	46.805ab	46.480 b	46.695ab	34.903 e	43.721 a
	Local	47.313 a	45.223 c	44.180 d	31.500 f	42.054 b
Means		47.059 a	45.852 b	45.438 b	33.202 c	

*__Bakrajo: LSD $_{(0.05)}$ for N= 1.585, V=0.424, C=0.480, N×V=0.599, N×C=0.678, V×C=0.__678, N×V×C=0.959__

__*Bazyan: LSD $_{(0.05)}$ for V=0.554, C=0.460, N×V=0.784, N×C=0.651, V×C=0.651, N×V×C= 0.921__

The (N x V) interaction showed that maximum 1000 grains weight (42.264, 44.113) were obtained from Ibba 99 variety receiving 40 kg N. ha^{-1}, whereas lowest number of 38.736 and 41.805 1000 grains weight (g) were produced by the interaction of Local variety receiving 80 and 40 N kg.ha^{-1} at Bakrajo and Bazyan locations, respectively. Our results are in line with (30) who reported that varieties, nitrogen levels and their interactions had significantly ($p>0.05$) affected 1000-grains weight In the (N x C) interaction maximum 1000-grains weight of 44.888 and 47.102 gm were obtained from interaction of 40 kg N.ha^{-1} with no cut, while lowest values (32.903, 32.417) gm were obtained from 40 and 80 kg N ha^{-1} and cut (C_3) for Bakrajo and Bazyan locations, respectively. Our findings are in line with (1) who suggested that the interaction of (C x N) was significant, thousand grains weight of wheat increased with N levels but thousand grains weight decrease when cut was applied. Hadi et al., (11) results are against these results who reported that the nitrogen levels applied, cutting and (N x C) all have no significant effect on 1000-grain weight. Niazkhani et al., (24) observed significant C, N and (C x N) effects in triticale in the (V x C) interaction

maximum 1000 grain weight (g) of 44.888 gm and 47.313 gm were obtained from interaction of Ibba 99 and Local with no cut, while lowest values (33.680, 31.500) were obtained from Ibba-99 and Local variety with cut (C_3) for Bakrajo and Bazyan locations, respectively. The (N x V x C) interaction revealed that maximum 1000 grain weight (gm) of 45.413and 47.547 were recorded from (40 kg N. ha^{-1} x Ibba 99 with $clip_2$) and 40 kg N.ha^{-1} x Local variety with (C_0) , whereas the lowest values of 32.847 gm and 31.267 gm were recorded at (80 kg N. ha^{-1} x Ibba 99 $clip_3$) and (40 kg N. ha^{-1} x Local variety clip C_3) for Bakrajo and Bazyan locations, respectively.

Harvest Index:

Rising harvest index (HI) has considered, in many status, for the yielded grain improvement in cereals (13) and it is influenced by surrounding environment (29), generally being higher with growing under favorable conditions. Effects variety, cut, (N x C), (V x C) and (N x V x C) were significant, while none of the

Table 6: Harvest Index of six-row barley as affected by cutting dates, varieties and nitrogen levels.

Bakrajo						
Nitrogen Kg. ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	0.359 a	0.291 b	0.230 c	0.075 f	0.239
40	Local	0.364 a	0.220 c	0.200 c	0.060 f	0.211
80	Ibba-99	0.370 a	0.198 c	0.285 b	0.152 d	0.251
80	Local	0.317 b	0.344 a	0.158 d	0.112 e	0.233
40		0.362 a	0.256 b	0.215 c	0.068 e	0.225
80		0.344 a	0.271 b	0.222 c	0.132 d	0.242
	Ibba-99	0.365 a	0.245 d	0.258 d	0.114 f	0.245 a
	Local	0.341 b	0.282 c	0.179 e	0.086 g	0.222 b
Means		0.353 a	0.263 b	0.218 c	0.100 d	

Bazyan						
Nitrogen Kg. ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	0.420 d	0.457bc	0.510 a	0.110 f	0.374
40	Local	0.460bc	0.410 d	0.450 c	0.087 g	0.352
80	Ibba-99	0.463bc	0.453bc	0.473 b	0.070 g	0.365
80	Local	0.443 c	0.473 b	0.373 e	0.077 g	0.342
40		0.440 c	0.433 d	0.480 a	0.098 e	0.363
80		0.453bc	0.463 b	0.423 d	0.073 f	0.353
	Ibba-99	0.442 b	0.455 b	0.492 a	0.090 d	0.370 a
	Local	0.452 b	0.442b	0.412 c	0.082 d	0.347 b
Means		0.448 a	0.448 a	0.452 a	0.086 b	

***Bakrajo: LSD $_{(0.05)}$ for V=0.010, C=0.016, N×C=0.023, V×C=0.023, N×V×C=0.032**
***Bazyan: LSD $_{(0.05)}$ for V= 0.016, C= 0.011, N×C= 0.015, V×C= 0.015, N×V×C=0.022**

N and N x V were significant on harvest index at the two locations (Table 6).Control (no cut=**C_0)** produced the highest harvest index 0.353 and 0.448, while cut 130 days after sowing (C_3) produced the lowest harvest index 0.100 and 0.086 for Bakrajo and Bazyan locations, respectively. Ibba-99 (binary purpose variety) produced more harvest index (0.245, 0.370) as compared to Local variety producing 35.92 and 0.347

harvest index at Bakrajo and Bazyan locations, respectively. Our results are in line with (3 and 4) who reported that cultivar had significant influence on barley harvest index. Shafi et al., (30) found that varieties, nitrogen levels and their interactions had significantly ($p>0.05$) affected harvest index. In the (N x C) interaction maximum harvest index of 0.362 and 0.480 were obtained from interaction of 40 kg N. ha^{-1} with no cut and cut_2, while lowest values (0.068, 0.073) were obtained from 40 and 80 kg N. ha^{-1} with (C_3) for Bakrajo and Bazyan locations, respectively. Afridi et al., (1) observed that wheat harvest index significantly increased with fertilizer-N treatments, while the cutting stress significantly decreased harvest index with no significant interaction among the variables was observed in this trait. Niazkhani et al., (24) observed significant effects in C, N and (C x N) in triticale. In the (V x C) interaction maximum harvest index of 0.365 and 0.492 were obtained from interaction of Ibba-99 with no cut and cut_2, while lowest values (0.086, 0.082) were obtained from Local variety and cut (C_3) for Bakrajo and Bazyan locations, respectively. The (N x V x C) interaction revealed that maximum harvest index of 0.370 and 0.510 were recorded from 80 and 40 kg N. ha^{-1} x Ibba-99 with no cut and cut_2, whereas the lowest values of 0.060 and 0.070 were recorded at 40 and 80 kg N. ha^{-1} x Local variety and Ibba-99 x cut (C_3) for Bakrajo and Bazyan locations, respectively.

Biological yield (t .ha^{-1}):

Effects of cut, (V x C, N x C) and (N x V x C) were significant on biological yield at the two locations and N at Bazyan location only (Table 8) Control (no cut C_0) and cut_1 produced the highest biological yield 13.383 and 11.263 t .h^{-1} while cut 130 days after sowing (C_3) produced the lowest biological yield 4.217 ton h^{-1} and 2.908 t.h^{-1} for Bakrajo and Bazyan locations, respectively. This reduction is due to removal of whole biomass during cut 80, 105 and 130 days after sowing, due to which secondary growth could not face the deficiency, due to shortage of time and nutrients. Low N (40 kg. ha^{-1}) produced minimum biological yield (8.563 t.h^{-1}). Each increment of N increased 8.563 t .h^{-1} and maximum yield (9.235) was recorded at 80 kg N. ha^{-1} at Bakrajo location, however, it was not significantly different from biological yield produced at Bazyan location. Ahmad and Rashid (2, 15 and 16) pointed that, with increased nitrogen application on barley cultivars concluded the biomass-related trait of leaf area was also increased by the application of N fertilizer. But Hadi et al., (11) findings are no significance on biological yield between N (40, 80) kg ha^{-1} applications. The (N x C) interaction maximum biological yield t. ha^{-1} of 13.9 was obtained from interaction of 80 kg N. ha^{-1} with no cut, while lowest values (3.783 t .h^{-1}) was obtained from 40 kg N ha^{-1} and cut (C_3) at Bakrajo location only. However Hadi et al, (10) cleared that cutting significantly affected the biological yield while nitrogen levels and (N x C) interaction were insignificant.

Table 7: Biological yield (t .ha^{-1}) of six row-barley as an affected by cutting dates, varieties and nitrogen levels.

Bakrajo						
Nitrogen Kg. ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	13.833ab	11.967 d	6.200 g	4.633 h	8.608
40	Local	13.967 a	11.747 d	6.867 f	4.667 h	8.517
80	Ibba-99	12.933 c	10.933 e	6.367 g	4.200 h	9.158
80	Local	12.800 c	13.333bc	4.567 h	3.367i	9.312
40		12.867 b	12.133 c	5.467 e	3.783 g	8.563 b
80		13.900 a	11.857 c	6.533 d	4.650 f	9.235 a
	Ibba-99	13.383 a	11.450 c	6.283 d	4.417 f	8.883
	Local	13.383 a	12.540 b	5.717 e	4.017 f	8.914
Means		13.383 a	11.995 b	6.000 c	4.217 d	

Bazyan						
Nitrogen Kg. ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	12.538ab	10.417bcd	9.500 cd	2.733 e	8.797
40	Local	9.567 cd	10.933bc	10.867bc	2.567 e	8.483
80	Ibba-99	7.833 d	11.500abc	9.700bcd	3.367 e	8.100
80	Local	14.100 a	12.200abc	9.467 cd	2.967 e	9.683
40		11.052	10.675	10.183	2.650	8.640
80		10.967	11.850	9.583	3.167	8.892
	Ibba-99	10.186	10.958	9.600	3.050	8.448
	Local	11.833	11.567	10.167	2.767	9.083
Means		11.009 a	11.263 a	9.883 b	2.908 c	

Bakrajo: LSD $_{(0.05)}$ for N= 0.614, C=0.312, N×C=0.441, V×C=0.441, N×V×C=0.624
Bazyan: LSD $_{(0.05)}$ for C=1.473, N×V×C=2.945.

In the (V x C) interaction maximum biological yield of 13.383 was obtained from interaction of dual purpose variety (Ibba-99) and or Local variety with no cut, while lowest values (4.017) was obtained from Local variety with cut (C_3) at Bakrajo locations only. The (N x V x C) interaction revealed that maximum biological yield t ha^{-1} of 13.967 and 14.100 were recorded from 40 and 80 kg N ha^{-1} x Local variety with no cut, whereas the lowest values of 3.367 and 2.567 were recorded at 80 and 40 kg N ha^{-1} x Local variety cut 130 days after sowing (C_3) for Bakrajo and Bazyan locations, respectively.

Grain yield (ton. ha^{-1}):

Grain yield is a complex trait relying upon more number of environmental, morphological and physiological traits. Yielded grains also depend upon other yield components. In our study, effects N, V, and C and all interactions at the two locations were significant on grain yield (t .ha^{-1}) with excepting of variety (V) and (N x C) at Bazyan and Bakrajo locations, respectively which was non-significant (Table 8).

Table 8: Grain yield (t .ha^{-1}) of six row-barley as an affected by cutting dates, varieties and nitrogen levels.

Bakrajo						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	4.640 b	3.179 e	1.454i	0.318 m	2.398 b
40	Local	4.660 b	2.942 f	0.906jk	0.204 m	2.178 c
80	Ibba-99	5.127 a	2.379 g	1.771 h	0.708 kl	2.496 ab
80	Local	4.437 c	4.043 d	1.085 j	0.526 l	2.523 a
40		4.650	3.061	1.180	0.261	2.288 b
80		4.782	3.211	1.428	0.617	2.509 a
	Ibba-99	4.884 a	2.779 d	1.612 e	0.513 g	2.447 a
	Local	4.549 b	3.493 c	0.995 f	0.365 h	2.350 b
Means		4.351 a	3.501 b	1.304 c	0.439 d	

Bazyan						
Nitrogen Kg ha^{-1} N	Varieties V	Cutting dates				Means
		No Cut C_0	C1 (80 DAS)	C2 (105 DAS)	C3 (130 DAS)	
40	Ibba-99	5.233 c	4.750def	4.819 de	0.308 i	3.777 b
40	Local	4.886 d	4.476fg	4.375 g	0.222 i	3.490 a
80	Ibba-99	5.419 c	5.187 c	4.555 efg	0.246 i	3.852 a
80	Local	6.216 a	5.770 b	3.542 h	0.223 i	3.938 a
40		5.059 c	4.613 d	4.597 d	0.265 f	3.634 b
80		5.817 a	5.479 b	4.048 e	0.234 f	3.895 a
	Ibba-99	5.326b	4.968c	4.687d	0.277 f	3.814
	Local	5.551 a	5.123bc	3.959 e	0.222 f	3.714
Means		5.311 a	5.046 b	4.450 c	0.250 d	

*Bakrajo: LSD $_{(0.05)}$ for N=0.254, V=0.152, C=0.149, N×V=0.216, V×C=0.141, N×V×C= 0.199
*Bazyan: LSD $_{(0.05)}$ for N=0.254, C=0.149, N×V= 0.216, N×C= 0.211, V×C= 0.211, N×V×C= 0.298

Control (no cut = C_0) produced the highest grain yield (t.ha^{-1}) 4.351 and 5.551, while cut (C_3) produced the lowest grain yield 0.439 and 0.222 t .ha^{-1} and the extent of decrease were (-89.91%,-96.00%) at Bakrajo and Bazyan locations, respectively. Similar findings have been reported by (7 and 21). However Kharub *et al*., (18) under multi-location experiment pointed that the barley crop could be given one cut at about 55 days after sowing for fresh forage in plains and the regenerated crop could be used for grain usage which gave satisfying grain yield, while Kharub *et al.*, (17) reported that at 55 days stage, the reduction in grain yield over cut at 40 days was around 25 % and (28) found the cutting at the stem erect stage (-28% and -27%) respectively for two sequence seasons. As well the data showed that among dual purpose barley varieties, Ibba-99 dual purpose variety produced more grain yield (2.447) as compared to Local variety producing 2.350 grain yield (t.ha^{-1}) and the extent of increase was 4.13 per cent at Bakrajo location. Similar findings were also reported by (31). Pandey, (27) and Tian *et al*., (36) found that N availability plays an important role in crop regrowth after defoliation. Low N (40kg .ha^{-1}) yielded minimum grain t.ha^{-1} (2.288, 3.634). Each increment of N increased (2.288, 3.634) and maximum yield (2.509, 3.895) were recorded at 80 kg N .ha^{-1} and the extent of decrease were (-8.80%, -6.70%) at Bakrajo and Bazyan locations, respectively. This agrees with what has

been recorded by Kharub *et al.* (17, 22 and 20). More ever, Hadi *et al*., (11) found that, N applied 40 kg .ha^{-1} gave maximum grain yield which was followed by 120 and 80 kg .ha^{-1} of nitrogen treatment respectively. The (N x V) interaction showed that maximum grain yield (t.ha^{-1}) (2.523, 3.938) were obtained from Local variety receiving 80 kg N. ha^{-1}, whereas lowest value of 2.178 t.ha^{-1} and 3.777 t.ha^{-1} grain yield were produced by the interaction of Local variety and binary purpose Ibba-99 receiving 40 N kg ha^{-1} at Bakrajo and Bazyan locations, respectively. Our results are in line with (4 and 30) who reported that varieties, nitrogen levels and their interactions had significantly ($p>0.05$) affected grain yield. In the (N x C) interaction maximum grain yield of 5.817 t .ha^{-1} was obtained from interaction of 80 and 40 kg. N. ha^{-1} with no cut, while lowest values (0.234 t.ha^{-1}) was obtained from 80 kg N ha^{-1} and cut (C_3) at Bazyan location. The observed relationship is in close agreement with finding of (32 and 24) in triticale. Our findings are against the findings of (10) who revealed that applied nitrogen, cutting and (N x C) interaction remained not significant for grain yield. These variations among the various results are probably due to variation in cutting severity and other environmental factors. In the (V x C) interaction maximum grain yield (t .ha^{-1}) of 4.884 and 5.551 were obtained from interaction of binary purpose variety Ibba-99 and Local variety with no cut, while lowest values (0.365, 0.222 t .ha^{-1}) were obtained from Local variety with cut (C_3) for Bakrajo and Bazyan locations, respectively. These results are in close conformity with the findings of (12). The (N x V x C) interaction revealed that maximum grain yield of 5.127 and 6.216 t .ha^{-1} were recorded from 80 kg N. ha^{-1} x Ibba-99 with no cut and 80 kg N. ha^{-1} x Local variety with no cut, whereas the lowest values of 0.204 and 0.222 t .ha^{-1} were recorded at 40 kg N ha^{-1} x Local variety cut (C_3) for Bakrajo and Bazyan locations, respectively (Table 8). These results are in close agreement with finding of (18 and 23) who suggested that significantly higher grain yield were recorded with barley variety RD 2552, 40 DAS and N (80 kg ha^{-1}).

In our results, however the Local variety can be taken for binary purpose as it is superior in grain, which it gave good yield (4.043, 5.770) t .ha^{-1} with $C_{1\ (80\ DAS)}$ and 80 kg N ha^{-1} at Bakrajo and Bazyan locations, respectively and it showed significant effects from the rest triple interactions of $C_{2\ (105\ DAS)}$ and $C_{3\ (130\ DAS)}$ over locations.

Conclusion :

he present study indicates that no cutting enhanced spike.m^{-2}, grains. spike^{-1}, 1000 grains weight, HI, biological yield and grain yield, however $C_{1\ (80\ DAS)}$ produced good grain yield and can be recommended for binary purpose. While 80 kg. ha^{-1} N application increased the spike. m^{-2}, 1000 grains weight, biological yield and grain yield. Moreover binary purpose variety Ibba-99 exceeded Local variety for spike m^{-2}, grains spike^{-1}, 1000 grains weight, HI and grain yield. Bazyan location exceeded Bakrajo location for grain yield and almost attributed traits due to favorable.

The Local variety with $C_{1\ (80\ DAS)}$ along with application of 80 kg Nitrogen. ha^{-1} recorded significantly higher grain yield from the rest triple interactions of $C_{2(105\ DAS)}$ and $C_{3(130\ DAS)}$ over locations and proved most efficient and economically viable practice for binary purpose barley.

References:

1. **Afridi. M. Z; Jan. M. T.; Arif. M. U. H. A. M. M. A. D and Jan, A. M. A. N. U. L. L. A. H. (2010)** Wheat yielding components response to different levels of fertilizer-N application time and decapitation strees. *Sarhad Journal of. Agriculture*, 26(4), 499-506.
2. **Ahmad, N., and Rashid, M. (2003)** Fertilizer use in Pakistan. *National Fertilizer Development Center, Planning and Development Division, Islamabad Google Scholar*.
3. **Mohammadi Aghdam, S., and Samadiyan, F. (2014)** Effect of nitrogen and cultivars on some of traits of barley (hordeum vulgare l.). *International Journal of Advanced Biological and Biomedical Research*, *2*(2), 295-299.
4. **Alazmani, A. (2015)** Evaluation of yield and yield components of barley varieties to nitrogen. *International Journal of Agriculture and Crop Sciences*, *8*(1), 52.
5. **AL Mohamad. F. and M.A. ALyounis. (2000)** Agricultural Experimentation Design and Analysis. Baghdad Univ. Ministry of Higher Education and Scientific research part (1) and (2), 374 and 444. (In Arabic).
6. **Cantero-Martinez, C., Villar, J. M., Romagosa, I., and Fereres, E. (1995)** Nitrogen fertilization of barley under semi-arid rainfed conditions. *European journal of agronomy*, *4*(3), 309-316.
7. **El-Shatnawi, M. K. J., and Haddad, N. I. (2004)** Assessing barley (Hordeum vulgare) response to clipping in the semi-arid Mediterranean climate. *Australian Journal of Experimental Agriculture*, *44*(1), 37-42.
8. **Guarda, G., Padovan, S., and Delogu, G. (2004)** Grain yield, nitrogen-use efficiency and baking quality of old and modern Italian bread-wheat cultivars grown at different nitrogen levels. *European Journal of Agronomy*, *21*(2), 181-192.
9. **Hadjichristodoulou, A. (1990)** Stability of 1000-grain weight and its relation with other traits of barley in dry areas. *Euphytica*, *51*(1), 11-17.
10. **Hadi, F., Hussain, F., and Arif, M. (2012)** Effect of different nitrogen levels and cutting on growth behavior of dual purpose barley (HordeumvulgareL.). *Scholarly J. Agril. Sci*, *2*(10), 263-268.
11. **Hadi. F.; Arif. M. & Hussain. F. (2012)** Response of dual purpose barley to rates and methods of nitrogen application. *Journal of Agricultural and Biological Science*, 7(7): 533-540.
12. **Hama. S. J.; Abdulqader. S. H.; Omare. B.; and Rashed, K. (2016)** The Effect of Cutting on Yield and Its Components of Six Genotypes of Barley Under Slaimani Condition. ICNS, 43, Pp 43-48.
13. **Hansen, J., Russell, G., Lacis, A., Fung, I., Rind, D., and Stone, P. (1985)** Climate response times: Dependence on climate sensitivity and ocean mixing. *Science*, *229*(4716), 857-859.
14. **Hayes. PM; Castro. A; Cedillo. LM; Corey. A; Henson. C; Jones. BL; Kling. J; Matus. D; Rossi. I; Sato. K.(2003)** Genetic diversity for quantitatively

inherited agronomic and malting quality traits. Elsevier science publishers, Amsterdam.

15. **Hussain, I., Khan, M. A., and Khan, E. A. (2006)** Bread wheat varieties as influenced by different nitrogen levels. *Journal of Zhejiang University Science B*, *7*(1), 70-78.
16. **Khalil, S. K., Khan, F., Rehman, A., Muhammad, F. I. D. A., Amanullah, K. A., Shah, M. K., AND Khan , H. (2011)** Dual purpose wheat for forage and grain yield in response to cutting, seed rate and nitrogen. *Pak. J. bot*, *43*(2), 937-947.
17. **Kharub. A. S.; R. P. S. Verma; and B. Sarkar. (2007)** Optimization of date of cutting for green fodder in dual purpose barley. DWR News, **1(1)**: 4
18. **Kharub. A. S.; R. P. S. Verma; D. Kumar; V. Kumar; R. S. Kumar; and Indu Sharma (2013)** Dual purpose barley (*Hordeum vulgare* L.) in India: Performance and potential. *Journal of Wheat Research*, 5(1): 55-58.
19. **Kozlowska-Ptaszynska, Z. (1989)** Changes in tillering and yield components of three spring barley cultivars as influenced by increasing nitrogen rates. Pamietnik Pulawski., 94: 119-131.
20. **Kumar. M.; Singh. B.; Jain. A. & Dhaka. A. (2017)** Dual Purpose barley–an effective solution for fodderscarcityin semi-arid region–a review. *Forage Research*, 42 (4): pp. 211-217.
21. **Lal. M. and Saini. K. S. (2017)** Productivity, Quality and Profitability of Dual Purpose Barley (Hordeum vulgare L.) Under Various Planting Techniques and Cutting Practices in Indo-Gangetic Plains of India. *International. Journal. Curr. Microbiol. App. Sci*, *6*(9): 648-654.
22. **Meena. L. R.; Mann. J. S.; and Meena, S. L. (2012)** Effect of levels and mode of nitrogen application on dual purpose barley (Hordeum vulgare) under semi-arid condition. *Indian Journal of Agronomy*, *57*(2): 168.
23. **Meena. N. K.; Gupta. V.; Mali. H. & Choudhary, J. (2017)** Performance of dual purpose varieties, cutting schedules and fertility levels to growth and productivity of barley (Hordium vulgare L.). *Journal of Pharmacognosy and Phytochemistry*, 6(4): 228-232.
24. **Niazkhani. M.; Khorshid. A., and Eivazi, A. (2014)** Evaluation Forage Clipping Stages and Different Levels of Nitrogen on Grain and Forage Yields of TRITICALE (× TRITICOSECALE WITTMACK). *American Journal of Plant Sciences*, 5(15), 2199.
25. **Oweis. T; Pala M; Ryan J. (1999)** Management alternatives for improved durum wheat production under supplemental irrigation in Syria. *European Journal of Agronomy*, 11: 255-266.
26. **Oweis. T. and Hachum, A. (2006)** Water harvesting and supplemental irrigation for improved water productivity of dry farming systems in West Asia and North Africa. *Agricultural Water Mnagement*, 80(13), 57-73.

27. Pandey. A. K. (2005) Effect of agronomic practices on green fodder, grain yield and economics of dual- purpose wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences*, 75 (1): 27-29.

28. Sadreddine. B. E. J. I. (2016) Yield and quality of dual-purpose barley and triticale in a semi-arid environment in Tunisia. *African Journal of Agricultural Research*, *11*(30): 2730-2735.

29. Samarrai. S.M.; S.M. Syeam; H.R. Mian and A.A. Dafie. (1987) Growth periods, harvest index and grain yield relationships in barley. *Rachis* 6:21-24.

30. Shafi. M.; Bakht. J. E. H. A. N.; Jalal. F. A. Z. A. L.; Khan. M. A. and Khattak, S. G. (2011) Effect of nitrogen application on yield and yield components of barley (Hordeum vulgare L.). *Pakistan Journal of Botany*, 43(3): 1471-1475.

31. Singh. M.; Chauhan. A.; Kumar. R.; Joshi. D.; Soni. P. G., & Meena, V. K. (2017) Dual purpose barley as affected by date of sowing, varietiesand stage of harvesting-A review. *Agricultural Reviews*, 38(2): 159-164.

32. Singh. R. P.; Tripathi. H. P. and Yadav, A. S. (2009) Effect of stages of cutting and nitrogen levels on grain and fodder yield of barley (*Hordium vulgare*). *Indian Journal of Agricultural Sciences*, *79*(1): 78-79.

33. Singh. V.P. and S.K. Uttam. (2000) Effect of farmyard manure and nitrogen levels on crop yield and economics of rice-wheat cropping system. Crop Research, 5: 82-86.

34. Suttie. J. M. and Reynolds, S. G. (Eds.) (2004) Fodder oats*:* a world overview (No. 33). Food and Agriculture Organization.

35. Thomason. WE; Brooks. WS; Griffey. CA; Vaughn. ME. (2009) Hulless barley seeding rate effect on grain yield and yield components. Crop Sciences, 49:342-46.

36. Tian. L. H.; L. W. Bell; Y. Y Shen; and J. P. M. Whish. (2012) Dual purpose use of winter wheat in western China:Cutting time and nitrogen application effects on phenology forage production and grain yield. *Crop Pasture Science*, 63: 520-528.

37. Yadav, R. K., Kumar, A., and Lal, D. (2003) Effect of cutting management and nitrogen levels on biomass production and proximate quality of barley (Hordeum vulgare) in saline soil. *Indian Journal of Agronomy*, *48*(3) 199-202.