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EFFECT OF DUAL PURPOSE VARIETIES, CUTTING SCHEDULES AND FERTILITY LEVELS ON NUTRIENT CONTENT, UPTAKE, QUALITY AND YIELD OF BARLEY (*HORDIUM VULGARE* L.)

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SUMMARY

A field experiment was conducted at Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, Udaipur (Rajasthan) during the **rabi** season of 2013-14. The experiment consisted combinations of two dual purpose barley varieties (RD 2715 and RD 2552), three cutting schedules (40, 50 and 60 DAS) and three fertility levels (RDF : 60 kg N+20 kg P_2O_5/ha, RDF+25% extra N and RDF+50% extra N). These 18 treatment combinations were evaluated under factorial randomized block design with three replications. The results revealed that variety RD 2552 recorded significantly higher N, P, K content and uptake by green fodder, grain and straw as compared to RD 2715. The significant improvement in total digestible nutrient (63.58%) and protein content (2.70%) of green fodder, grain (9.27%) and straw (1.66%) of variety RD 2552 over RD 2715 but mineral ash, crude fiber and green fodder yield were highest in RD 2715 as compared to RD 2552. Variety RD 2552 recorded significantly higher grain, straw and biological yield over RD 2715. Cutting of green fodder done at 60 DAS recorded highest N, P , K and protein content in green fodder, grain and straw compared to 40 and 50 DAS. The grain, straw and biological yield as well as nutrient uptake by grain and straw were significantly increased when green fodder was cut at 40 DAS, while cutting at 60 DAS recorded the highest nutrient uptake by green fodder. The mineral ash and crude fiber in green fodder were higher when green fodder was cut at 60 DAS as compared to earlier cutting. The maximum N, P, K content and uptake in grain and straw were estimated under application of RDF+50 per cent extra N. While, N uptake by green fodder recorded higher under application of RDF+25 per cent extra N but it was at par with RDF+50 per cent extra N. The highest protein content in green fodder, grain and straw was recorded under RDF+50 per cent extra N, the same trend was observed in regards of TDN and mineral ash content in green fodder. Effect of 50 per cent extra nitrogen application on yield attributes was also reflected on yield and ultimately produced the highest green fodder (29.78 t/ha), grain (3.56 t/ha), straw (6.86 t/ha) and biological yield (10.42 t/ha).

Key words : Barley, cutting schedules, N, P and K content, uptake, protein content, TDN, mineral ash, crude fiber, yield, RDF

Barley (*Hordeum vulgare* L.) is a valuable crop because it is used for food, processed food and feed for livestocks. Besides these conventional uses, it is an important industrial crop. In recent past, India has made an impressive progress in achieving self sufficiency in food grain production by increasing the productivity of several crops. However, forage production for livestock is limited. In India, Rajasthan ranks first in barley area and it was cultivated on 0.31 m ha area during 2012-13 with 0.85 m t of production at an average productivity status of 27.7 q/ha (DWR, 2013-14). Barley possesses high total biomass, thus the small and marginal farmers of our country used green barley fodder for milch animals. Looking to its high total biomass and salt tolerance nature, there has been an increasing interest in exploiting barley as a dual purpose cereal which can permit forage production in early season in addition to the grain yield at later stage (DWR, 2010). Suitable high yielding variety, cutting schedules and mineral fertilization are considered to be most important pre-requisite for realizing higher green fodder as well as grain yield (Thomson *et al*., 2009). Considering these facts

and paucity of research findings on these aspects, the present study was undertaken to study the effect of dual purpose barley (*Hordium vulgare* L.) cutting schedules and fertility levels on nutrient content, uptake, quality and yield during *rabi* 2013-14.

MATERIALS AND METHODS

The experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur. The site is situated in south-eastern part of Rajasthan at an altitude of 579.5 m above mean sea level at 24°35' N latitude and 74°42' E longitude. The region falls under agro-climatic zone IV a (Sub - Humid Southern Plain and Aravalli Hills) of Rajasthan. The experiment consisted of 18 treatment combinations comprising two varieties (RD 2715 and RD 2552), three cutting schedules (40, 50 and 60 DAS) and three fertility levels *viz*., RDF (60 kg N+20 kg P_2O_5/ha), RDF+25 per cent extra N and RDF +50 per cent extra N. The extra N was applied after green fodder cutting. The experiment was laid out in factorial randomized block design with three replications. The soil of experimental site was clay loam in texture, having slight alkaline reaction (pH 8.1). The soil was medium in available nitrogen (295.3 kg/ha), phosphorus (18.4 kg/ha) and high in available potassium (292.7 kg/ha). The crop was sown manually on 23 November, 2013 in furrows opened at 22.5 cm apart and seeds were placed at a depth of 3-4 cm, using seed rates 100 kg/ha. The dual purpose barley crop was harvested first for green fodder at 40, 50 and 60 DAS as per treatment. After harvest of green fodder, the crop was raised for grain purpose. In RDF, the entire quantity of phosphorus and 1/2 of the nitrogen (30 kg/ha) were drilled in the furrows about 5 cm below seeding zone at the time of sowing and remaining 1/2 dose of nitrogen (30 kg/ha) was top dressed at the time of 1st irrigation, While the extra N was applied after green fodder cutting. The crop was harvested for grain production on 10 April 2014. The total digestible nutrients, crude fiber, protein, nitrogen, phosphorus contents and uptake were estimated by using standard methods for analysis and formula.

RESULTS AND DISCUSSION

Effect of Varieties

The estimates of N, P and K contents of green fodder (0.432, 0.350 and 1.702%), grain (1.483, 0.407 and 0.697%) and straw (0.226, 0.0698 and 1.282%) indicated significant increase in variety RD 2552 over RD 2715 (Table 1). Similarly, N, P and K uptakes were higher in RD 2552 as compared to RD 2715 (Table 2). The significant increase in N, P and K contents of green fodder, grain and straw was on account of capabilities of RD 2552 for efficient absorption, translocation and utilization of mineral nutrients. Moreover, the increased dry matter accumulation by the variety RD 2552 subscribes to the view that there was adequate translocation of metabolites from shoot to roots. This might have facilitated better root growth thus higher extraction of nutrients from soil environment. The increased content of nutrients in the grain of variety RD 2552 was expected as most of nutrients from vegetative parts are translocated to seeds. Nutrient uptake by grain and straw increased with genotype RD 2552 (Table 2). As the uptake is a product of the yield and nutrient content, considerable increase in either of components may increase the uptake. Thus, improvement in green fodder yield and nutrient content and grain, straw yield and their nutrient content in variety RD 2552 led to higher accumulation of nutrients. The significant improvement in protein content (2.70%) of green fodder of variety RD 2552 over RD 2715 might be on account of increased N content. After green fodder cutting variety RD 2552 exhibited significant improvement in protein content of grain (9.27%) and straw (1.66%) (Table 3). In the preceding section, the role of N in improving protein content was well emphasized. The results are in close agreement with the findings of Rawat **(**2011). The significant increase in TDN (63.58%) of variety RD 2552 as compared to variety RD 2715 but the increase in ash content (7.68%) and crude fiber (30.50) in variety RD 2715 (Table 3).

Data (Table 4) indicated that barley variety RD 2715 had higher green fodder yield over RD 2552. The improvement in green fodder yield is sum of growth contributing factors controlled by genetically and agronomical manipulation both. Maximization in fodder yield seems to be on account of overall improvement in growth as evinced from taller plant, higher production of tillers and dry matter as well as N and P uptake by green fodder which subscribes to be the view that there was greater availability of growth inputs matching with formation and development of fodder yield components. Similar findings were also reported by Tulsa and Lal (2009) and Rawat (2011). Results indicated that after cutting when done for green fodder purpose barley

variety RD 2552 recorded significant increase in yield attributing characters as compared to variety RD 2715. The significant improvement in yield components in variety RD 2552 manifested in increased productivity of this variety in terms of grain, straw and biological yield by 16.55, 5.02 and 8.93 per cent, respectively, over RD 2715 (Table 4).

Cutting Schedules

The results (Table 1) showed that green fodder cutting done at 60 DAS recorded highest N, P and K content in green fodder (0.431, 0.352 and 1.708%), grain (1.507, 0.413 and 0.685%) and straw (0.268, 0.661 and 1.273%) compared to 40 and 50 DAS. The N, P and K uptake by grain (57.84, 16.01 and 26.54 kg/ha) and straw (18.06, 4.57 and 87.64 kg/ha) was significantly increased under cutting at 40 DAS, while cutting of 60 DAS recorded highest nutrient uptake by green fodder (Table 2). It is established fact that nutrient uptake by the crop largely depends on its growth and development. Primarily, it is a function of dry matter production and secondarily the concentration of nutrients at cellular level. Further, the late green fodder cutting also accumulated higher dry matter by virtue of increase in morphological parameters and finally photosynthetic rate. The correlation studies also substantiated positive interrelationship of N, P and K uptake with grain (r= 0.956, 0. 984 and 0.974) ** and straw yield (r= 0.918, 0.823 and 0.966)**, respectively. Further, regression analysis indicated a unit increase in grain and straw yield increase in N uptake by 1.517 and 0.261 kg/ha, P uptake by 0.396 and 0.074 kg/ha, and K uptake by 0.644 and 1.226 kg/ha, respectively. Thus, the observed crop behaviour under present study could be ascribed only to increased biomass and nutrient content which ultimately increased nutrient accumulation in plant parts. The analysis of green fodder, grain and straw (Table 3) revealed that the protein content in green fodder**,** grain and straw was significantly influenced by different cutting schedules. It is well established fact that N is constitute of protein and in present investigation green fodder cutting at 60 DAS gave significantly higher N content in green fodder, grain and straw which ultimately increased protein content of green fodder (2.70%), grain (9.43%) and straw (1.67%). The decrease in TDN content with delay in cutting schedules could be due to synthesis of more structural carbohydrates, while

TABLE 1
Effect of cutting schedules and fertility levels on N, P and K content by green fodder, grain and straw of barley dual purpose varieties

Treatment	N content (%)			P content (%)			K content (%)		
	Green fodder	Grain	Straw	Green fodder	Grain	Straw	Green fodder	Grain	Straw
Varieties									
RD 2715	0.421	1.461	0.257	0.345	0.401	0.0611	1.500	0.648	1.236
RD 2552	0.432	1.483	0.266	0.350	0.407	0.0698	1.702	0.697	1.282
S. Em±	0.001	0.008	0.002	0.001	0.002	0.0003	0.007	0.004	0.004
C. D. (P=0.05)	0.004	0.022	0.004	0.003	0.006	0.0008	0.021	0.012	0.012
Cutting schedules (DAS									
40	0.421	1.400	0.255	0.344	0.390	0.0644	1.522	0.652	1.235
50	0.428	1.507	0.262	0.347	0.410	0.0659	1.572	0.682	1.269
60	0.431	1.509	0.268	0.352	0.413	0.0661	1.708	0.685	1.273
S. Em±	0.002	0.009	0.002	0.002	0.003	0.0003	0.009	0.005	0.005
C. D. (P=0.05)	0.005	0.027	0.005	0.004	0.008	0.0010	0.026	0.015	0.015
Fertility Levels									
RDF (60 kg N+20 kg P_2O_5/ha)	0.424	1.441	0.254	0.345	0.398	0.0643	1.585	0.664	1.238
RDF+25% extra N	0.426	1.467	0.263	0.349	0.408	0.0658	1.596	0.672	1.268
RDF+50% extra N	0.430	1.508	0.266	0.350	0.406	0.0662	1.622	0.683	1.271
S. Em±	0.002	0.009	0.002	0.001	0.003	0.0003	0.009	0.005	0.005
C. D. (P=0.05)	0.005	0.027	0.005	0.004	0.008	0.0010	0.026	0.015	0.015

mineral ash content (8.06%) and crude fiber (30.55%) were significantly increased when delaying in fodder cutting and it was recorded maximum at 60 DAS compared to 40 and 50 DAS (Table 3). Similar findings were also reported by Sirohi (2001) and Singh *et al.*, (2013). The grain (4.09 t/ha), straw (7.09 t/ha) and biological yield (11.18 t/ha) were significantly higher when cutting was done at 40 DAS for green fodder but green fodder yield was produced highest at 60 DAS (Table 4). For dual purpose barley crop, the stage for forage cutting is most important on which both forage and grain yield depend. If cut is given early, forage yield will be reduced and if cut is given slight late, plant regeneration and the grain yield will be affected. Delayed cutting reduced the proper regrowth of the crop and resulted in lower grain and straw yield. Similar findings were recorded by Kharub *et al*. (2013).

Fertility Levels

The results of plant analysis (Table 1) revealed that application of RDF+50 per cent extra N significantly increased nutrients content (N, P and K) in green fodder (0.430, 0.350 and 1.622%), grain (1.508, 1.406 and 0.683%) as well as straw (0.266, 0.0662 and 1.271%) compared to RDF and RDF+25 per cent extra N. Alike concentration, the accumulation of these nutrients in above plant parts also showed positive influence under the effect of RDF+50 per cent extra N. Under addition of RDF+50 per cent extra N significantly increased nutrients uptake (N, P and K) by grain as well as straw compared to RDF and RDF+25 per cent extra N fertilization (Table 2).

The higher protein content in green fodder, grain and straw was recorded under RDF+50 per cent extra N, the same trend was observed in regards of TDN and mineral ash content in green fodder. The significant improvement in nutritional status of grain and straw could be ascribed to their greater availability of nutrients in soil environment along with extraction and translocation towards plant system. In the preceding section, the role of N and P fertilization in improving congenial conditions in plant system for higher extraction of nutrient was well emphasized. It is generally believed that in plant system extracted nutrients are used for maintaining their critical concentration, which can be used for growth of developing structures. Thus, greater availability of nutrients (Table 4) with additional N seems to have maintained critical concentration at cellular level, fulfilled their requirements for profuse plant growth and their efficient translocation

TABLE 2
Effect of cutting schedules and fertility levels on N, P and K uptake by green fodder, grain and straw of dual purpose barley varieties

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	Green fodder	Grain	Straw	Green fodder	Grain	Straw	Green fodder	Grain	Straw
Varieties									
RD 2715	38.05	43.79	15.79	31.11	11.91	3.76	135.26	19.42	76.09
RD 2552	36.36	52.07	17.22	29.44	14.39	4.53	145.18	24.44	83.01
S. Em±	0.81	1.05	0.26	0.64	0.32	0.07	3.07	0.50	1.35
C. D. (P=0.05)	N.S	3.00	0.74	NS	0.93	0.19	8.83	1.42	3.88
Cutting Schedules									
40 DAS	25.92	57.84	18.06	21.12	16.01	4.57	92.29	26.54	87.64
50 DAS	33.02	52.45	15.81	26.78	14.27	3.99	121.75	23.63	76.48
60 DAS	52.69	33.52	15.66	42.91	9.17	3.88	206.63	15.62	74.52
S. Em±	0.99	1.28	0.32	0.78	0.40	0.08	3.76	0.61	1.65
C. D. (P=0.05)	2.83	3.68	0.91	2.24	1.14	0.23	10.81	1.74	4.76
Fertility Levels									
RDF (60 kg N+20 kg P_2O_5/ha)	32.69	40.63	15.04	26.58	11.36	3.80	121.06	19.21	73.36
RDF+25% extra N	39.57	49.16	16.26	32.26	13.70	4.08	149.89	22.43	78.14
RDF+50% extra N	39.36	54.01	18.23	31.97	14.39	4.56	149.71	24.15	87.14
S. Em±	0.99	1.28	0.32	0.78	0.40	0.08	3.76	0.61	1.65
C. D. (P=0.05)	2.83	3.68	0.91	2.24	1.14	0.23	10.81	1.74	4.76

NS–Not Significant.

towards sink component (straw and grain). Similar findings were also reported by Kumawat and Jat (2005) and Shaktawat and Shekhawat (2010). It is an established fact that nutrient accumulation depends upon dry matter accumulation and concentration of nutrient at cellular level. The concomitant improvement in both of these components reflected higher accumulation of nutrients. The relationship analysis also narrated positive relationship between grain, straw yield and uptake of N (r = 0.0.956 and 0.918)**, P (r = 0.984 and 0.823)** and K (r = 0.974 and 0.966)** by grain and straw. The results of present investigation were strongly supported by Kumar *et al*. (2011) and Meena *et al*. (2011).

The improvement in protein content under the influence of additional N fertilization seems to be on account of increased N content of grain. It is well known fact that N is a constituent of protein, enzymes and chlorophyll and participates in several biochemical processes for the metabolism of carbohydrate, fat and protein in plant system. Similar findings were also reported by Singh and Singh (2005). Increase in crude protein content of fodder due to nitrogen application was obvious as increased availability of nitrogen to crop plants led to more absorption and thus resulted in increased nitrogen accumulation in plants, which contributed to crude protein content. Several workers have reported similar effects of barley (Hedi *et al*., 2012; Choudhary and Prabhu, 2014). Protein yield, being a function of dry matter and crude protein content, logically ascribes the significant increase so recorded here in the present study. Significant increase in crude fat and mineral matter contents due to nitrogen application was also noticed in the present study. It is interesting to indicate that when plants remain more in meristematic activity, the respiration process becomes rapid and in rapid process of respiration, most of the carbohydrates are converted into fats. Thus, with the application of nitrogen not only protein content is improved but mineral salts and crude fats are also improved. Similar findings were observed by Kawaka *et al*., (2009) and Choudhary *et al.* (2014). The regression studies (Table 5.1) also affirmed profound influence of N content of grain and protein content (r = 1.000)**. The TDN content was also significantly higher under additional N and P fertilization. These results are in close agreement with the findings of Rawat (2011).

TABLE 3

Effect of cutting schedules and fertility levels on quality of green fodder, grain and straw of dual purpose barley varieties

Treatment	Protein content (%)			TDN (%)	Mineral content (%)	Crude (%)
	Green fodder	Grain	Straw			
Varieties						
RD 2715	2.63	9.13	1.61	63.41	7.68	30.50
RD 2552	2.70	9.27	1.66	63.58	7.57	29.98
S. Em±	0.009	0.05	0.01	0.03	0.03	0.06
C. D. (P=0.05)	0.025	0.14	0.03	0.09	0.09	0.17
Cutting Schedules						
40 DAS	2.63	8.75	1.59	63.74	7.36	29.95
50 DAS	2.67	9.42	1.63	63.61	7.45	30.22
60 DAS	2.70	9.43	1.67	63.13	8.06	30.55
S. Em±	0.011	0.06	0.01	0.04	0.04	0.07
C. D. (P=0.05)	0.030	0.17	0.03	0.11	0.11	0.20
Fertility Levels						
RDF (60 kg N+20 kg P_2O_5/ha)	2.65	9.00	1.59	63.46	7.61	30.48
RDF+25% extra N	2.66	9.17	1.65	63.49	7.62	30.34
RDF+50% extra N	2.69	9.43	1.66	63.53	7.64	29.91
S. Em±	0.011	0.06	0.01	0.04	0.04	0.07
C. D. (P=0.05)	NS	0.17	0.03	NS	NS	0.20

NS–Not Significant.

TABLE 4
Effect of cutting schedules and fertility levels on yield and harvest index of dual purpose barley varieties

Treatment	Yield (t/ha)				Harvest index (%)
	Green Fodder	Grain	Straw	Biological	
Varieties					
RD 2715	28.46	3.01	6.17	9.18	31.97
RD 2552	26.78	3.52	6.48	9.99	34.94
S. Em±	0.70	0.07	0.11	0.12	0.70
C. D. (P=0.05)	NS	0.21	0.31	0.35	2.00
Cutting Schedules					
40 DAS	23.99	4.09	7.09	11.18	36.75
50 DAS	29.08	3.46	6.03	9.49	36.30
60 DAS	29.80	2.24	5.85	8.09	27.32
S. Em±	0.86	0.09	0.13	0.15	0.85
C. D. (P=0.05)	2.48	0.25	0.38	0.43	2.45
Fertility Levels					
RDF (60 kg N+20 kg P_2O_5/ha)	24.30	2.86	5.94	8.80	32.20
RDF+25% extra N	28.79	3.37	6.17	9.54	34.34
RDF+50% extra N	29.78	3.56	6.86	10.42	33.83
S. Em±	0.86	0.09	0.13	0.15	0.85
C D (P=0.05)	2.48	0.25	0.38	0.43	2.45

NS–Not Significant.

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