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Effect of balanced fertilization on green fodder yield, quality and nutrient uptake by dual purpose barley (*Hordeum vulgare* L.) varieties

Vinod Kumar, PC Chaplot, J Choudhary and MK Kaushik

Abstract
A field experiment was conducted during *rabi* season of 2013-14 to study effect of balanced fertilization on growth, green fodder yield and nutrient uptake by dual purpose barley varieties at the instructional farm, Rajasthan college of agriculture, Udaipur. The experiment was laid out in RBD (Factorial) with 14 treatment combinations replicated thrice. The treatment consisted of seven balanced fertilization (no fertilization, N, NP, NPK, NPKS, NPKZn, NPKSZn) applied at recommended level and two varieties (RD 2715, RD 2552). The results indicated that dual purpose barley variety RD 2715 recorded significantly higher plant height, total tillers and dry matter accumulation at 55 DAS, thereby produced significantly higher green fodder yield by 14.5 per cent over variety RD 2552. This variety also recorded highest uptake of N, P, K,S and Zn by fodder and TDN in green fodder. The crop fertilized with N, NP, NPK, NPKS, NPKZn and NPKSZn at recommended level significantly increased growth, green fodder yield, nutrient uptake and quality over control. Among balanced fertilization, application of NPKSZn recorded significantly higher green fodder yield by 16.7 per cent over NPK closely followed by NPKS. This nutrient combination also recorded higher N, P, K, S and Zn status in dry fodder and TDN content in green fodder.

Keywords: Dual purpose barley, balanced fertilization, green fodder, yield, uptake, quality

Introduction
Barley (*Hordeum vulgare* L.) is a valuable crop because it is used for food, processed food and feed for livestock. Besides there 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 elevating productivity of several crops. However, forage production for livestock is limited and costly due to erratic rainfall especially in Rajasthan. It occupied 2.7 lac ha acreage with the production of 8.31 lac tones at an average productivity of 28.8 q ha^{-1} (IIWBR. 2019-20) [4]. Barley possesses' high total biomass thus the small and marginal farmers of our country used green barley fodder as feed 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 later on (Kumar *et al.*2017) [5]. The potential of specific variety as dual purpose depends on the environment and management practices *i.e.* time of sowing, scheduling and cutting management etc. Large variability among the barley lines for green fodder yield and grain yield from the regenerated crop has been reported (Sohu *et al.* 2017) [8]. It is therefore very important to screen germplasm that gives high green fodder yield and good quality fodder. Despite the application of recommended qualities of major plant nutrients, the increase in yield is not encouraging. These indicate that in addition to major plant nutrient these are needed to supply S and Zn. N, P and K are the major primary nutrient which is important constituent of protein, chlorophyll and various enzymes involved in metabolic processes. N being mobile nutrient in plant as well as in soil increases the vegetative as well as reproductive growth of the plant. P is major constituent of sugar phosphate, nucleic acid and phospholipids. K not only help in raising good crop but can help in escaping several diseases also, S play in important role in formation of amino acid, synthesis of protein and chlorophyll formation. Zn play outstanding role in synthesis of chlorophyll, Protein and also regulate water absorption and involved in synthesis of IAA, GA and RNA (Chandrasekaran *et al.* 2010) [1]. Therefore in the recent years micronutrients are considered as one of the constraints in the optimum production of barley crop.

An attempt has been made to review the impact of balanced fertilizers on the dual purpose barley varieties.

Materials and Methods

Afield experiment was laid out at the Instructional Farm, Rajasthan College of Agriculture, Udaipur during *rabi* season of the year 2013-14. The soil of the experimental field was clay loam in nature, slightly alkaline in reaction (pH 7.8), medium in available nitrogen (295.3 kg ha^{-1}) and phosphorus (16.6 kg ha^{-1}) and high in available potassium status (275.3 kg ha^{-1}) the experiment consists of 14 treatment comprising combination of two varieties (RD 2715 and RD 2552) and seven balanced fertilization system (no fertilizer (control), 60 kg N ha^{-1}(N), N + 20 kg $P_2O_5ha^{-1}$(NP), NP + 20 kg K_2O ha^{-1}(NPK), NPK +40 kg S ha^{-1}(NPKS), NPK + 5 kg Zn ha^{-1}(NPKZn and NPKSZn). These were evaluated in RBD (Factorial) with three replications. The seed were sown in furrows opened at 22.5 cm apart and seeds were placed at a depth of 4-5 cm using seed rate of 100 kg ha^{-1}. The sources of N, P, K, S and Zn were urea, DAP, MOP, gypsum and zinc sulphate respectively. The whole quantity of P, K, S, Zn and half dose of N were drilled in furrow before sowing. The remaining half doses of N were applied in two equal splits *i.e.* at 30-35 DAS and just after first cutting. The barley varieties as per treatment were sown on 25thNovember. The crop was irrigated thrice *i.e.* at 30, 55 and 95 DAS. The crop was harvested first for green fodder at 55 DAS, after harvesting green fodder, applied N and irrigation which were raised for grain purpose.

Results and Discussion

Varieties

Data (Table 1&2) show that at green fodder cutting variety RD 2715 attained highest plant height, total tillers and dry matter accumulation m^{-1} row length which was significantly higher by 12.2, 9.7 and 24.4 per cent, respectively over variety RD 2552. The increased plant height and total tillers of variety RD 2715 seems to have increased interception, absorption and utilization of radiant energy resulting in higher accumulation of photosynthates and finally dry matter in variety RD 2715. Further dual-purpose variety RD 2715 produced significantly higher green fodder yield which was higher by 14.5 per cent over variety RD 2552. This variety brought about significantly higher N, P, K, S and Zn concentration in dry fodder compared to variety RD 2552. It is generally believed that plant extracted nutrients are used for maintaining their critical concentration that can be used for development structures. Thus greater availability of nutrient with variety RD 2715 seems to have critical concentration at cellular level and fulfilled their requirement for profuse plant growth and their efficient translocation towards sink components. The results are in accordance with findings of Singh *et al.* (2012) [7]. Data further shows that dual purpose variety RD 2715 accumulated highest quantum of N, P, K, S and Zn by dry fodder which was significantly higher by 9.3, 9.7, 10.4, 8.0 and 9.2per cent, respectively over variety RD 2552. The highest green fodder yield in variety RD 2715 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, P, K, S and Zn uptake by dry fodder which subscribes to be the view that there was greater availability of growth inputs matching with formation and development of fodder yield component. The variety RD 2715 also recorded significantly higher percentage TDN in fodder as compared to RD 2552.The results confirm findings of Meena *et al*. (2016) [6].

Table 1: Effect of dual purpose barley varieties and balanced fertilization on growth, green fodder yield and nutrient content in dry fodder

Treatments	Growth at green fodder cutting (55 DAS)			Green fodder yield at 55 DAS (q ha^{-1})	Nutrient content in dry fodder				
	Plant height (cm)	Total tillers (m^{-1} row length)	Dry matter accumulation (g 0.5 m^{-1} row length)		N (%)	P (%)	K (%)	S (%)	Zn (ppm)
Varieties									
RD 2715	64.3	139.6	45.0	313.6	0.439	0.360	1.572	0.785	11.90
RD 2552	57.3	127.3	36.2	273.9	0.420	0.345	1.516	0.741	11.35
SEM	1.09	2.14	1.22	6.60	0.002	0.001	0.016	0.005	0.10
CD	3.17	6.24	3.55	19.19	0.007	0.003	0.046	0.015	0.29
Balanced fertilization									
No fertilizer	48.0	106.7	23.8	181.9	0.384	0.325	1.113	0.593	10.34
N	55.9	123.3	35.0	265.5	0.420	0.344	1.452	0.730	11.10
NP	58.0	129.3	38.9	281.6	0.430	0.354	1.522	0.746	11.49
NPK	61.8	135.6	41.8	306.0	0.435	0.356	1.622	0.756	11.59
NPKS	68.4	147.1	48.6	346.2	0.450	0.364	1.722	0.845	12.21
NPK Zn	63.7	139.6	44.5	318.0	0.437	0.358	1.642	0.818	12.23
NPKSZn	69.7	151.8	51.7	357.1	0.452	0.365	1.732	0.857	12.39
S.Em	2.04	4.01	2.28	12.35	0.005	0.002	0.030	0.009	0.19
CD	5.93	11.67	6.64	35.91	0.014	0.006	0.086	0.028	0.54

Table 2: Effect of dual purpose barley varieties and balanced fertilization on nutrient uptake by dry fodder and quality

Treatments	Nutrient uptake (kg ha^{-1})					TDN (%)
	Nitrogen	Phosphorus	Potassium	Sulphur	Zn	
Varieties						
RD 2715	32.9	27.0	118.8	58.1	0.889	63.17
RD 2552	30.1	24.6	107.6	53.8	0.814	62.87
SEM	0.84	0.62	2.61	1.39	0.022	0.04
CD	2.43	1.80	7.56	4.03	0.064	0.13
Balanced fertilization						
No fertilizer	17.5	14.8	50.6	27.0	0.470	62.27
N	27.9	22.8	96.4	48.4	0.737	62.78
NP	30.2	24.9	107.2	52.5	0.808	62.94
NPK	33.3	27.2	124.1	57.8	0.886	63.06
NPKS	39.0	31.5	149.0	73.1	1.056	63.45
NPK Zn	34.7	28.5	130.5	65.0	0.972	63.19
NPKSZn	40.4	32.6	154.6	76.5	1.106	63.49
S.Em	1.57	1.16	4.89	2.59	41.8	0.08
CD	4.56	3.37	14.22	7.55	121.5	0.25

Balanced fertilization

It is inferred from data (Table 1&2) that balanced fertilization significantly increased growth, yield, nutrient content and uptake by green fodder cutting. Application of N and in conjunction with P, PK, PKS, PKZn and PKSZn at recommended level significantly increased plant height, total tillers, dry matter accumulation and green fodder yield over no fertilizer application. The magnitude of increase in green fodder yield was to the tune of 45.9, 54.8, 68.2, 74.8, 90.3 and 96.3 per cent, respectively. Among balanced fertilization, conjoint application of NPKSZn recorded significantly higher plant height, total tillers and dry matter accumulation thus crop led significantly higher green fodder yield by 16.7 and 12.3 per cent, respectively over NPK and NPKZn fertilization. This nutrient combination was closely followed by NPKS fertilization which significantly increased green fodder yield by 13.1 per cent over application of NPK. The profound increase of balanced fertilization on various growth parameters seems to be due to improvement in nutritional environment of plant. Thus crop might have enhanced meristematic activities, thereby increased division, enlargement and elongation of cells resulting in higher plant height. Likewise significant improvement in tillers could be attributed to enhanced growth of lateral buds. This improvement seems to have increased photosynthetic efficiency resulting in higher production of fodder. The results of present investigation corroborated with the findings of Chaplot and Sumeriya (2013) [2]. The crop fertilized with recommended dose of N, NP, NPK, NPKS, NPKZn and NPKSZn significantly increased concentration and uptake of N, P, K, S and Zn by dry fodder over no fertilization. The balanced fertilization comprised combination of NPKSZn recorded highest N, P, K, S and Zn status in dry fodder thus accumulated higher quantum of nutrients in dry fodder as compared to NPK. The corresponding increase in N, P, K, S and Zn uptake by dry fodder due to NPKSZn application was of the order of 21.3, 19.9, 24.6, 32.3 and 24.8 per cent, respectively. This nutrient combination was closely followed by NPKS fertilization which increased N, P, K, S and Zn uptake by 17.1, 15.8, 20.2, 26.5 and 19.2 per cent, respectively. The positive influence of conjoint application of NPKSZn on nutrient status of plant seems to be due to their increased availability in root zone. Alike this balanced fertilization involving combination of NPKSZn, NPKS and NPKZn increased quality of green fodder estimated in per cent of TDN over NPK. This improvement seems to be on account of increased N, P, K, S and Zn concentration in green fodder. The results are in accordance with the findings of Choudhary and Chaplot (2015) [3].

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