Comparative Analysis of Fodder and Grain from Dual Purpose Barley vis-a- vis Local Variety in Hills of Uttarakhand, India

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ABSTRACT

Central to the challenge of feed scarcity in hills of Uttarakhand, trials were conducted in hill state of Uttarakhand India in two location of Tehri Garhwal and Pithoragarh districts for fodder grain and residue yields under different management. Fodder quality of the feed was analyzed using proximate principles. Results revealed that, the improved variety BHS 380 performed better in terms of fodder, grain and straw yields. Location wise, the performance in terms of grain and straw yield was commendable in Pithoragarh compared to Tehri Garhwal. In Tehri Garhwal BHS 380 produced substantially higher quantities of grain (4.78t-ha), straw (7.31t-ha) besides 3.78t-ha of green fodder during lean season, likewise in Pithorgarh district BHS 380 yielded higher quantity of grain (7.23 t-ha) and straw(13.80t-ha) besides 1.28 t-ha of green fodder during lean season, under delayed sowing in December. Crude protein in green fodder of BHS 380 was more than the local and can result in quality feeding in fodder scarce season for livestock.

Key words: *Dual purpose; Barley; Dry matter; Green fodder harvest;*

Barley (*Horedum vulgare* L) is the one of the first domesticated cereals one of the founder crops of old world agriculture and was one of the first domesticated cereals. It is fourth largest cereal crop after maize, wheat and rice in the world with a share of 7 per cent of the global cereal production. The crop is considered as poor man's crop and better adaptable to problematic soils and marginal lands. It is not only useful for malting, feed and food purposes but also its β-glucanse is helpful in lowering the risk of cardio-vascular diseases (*Kharub et al. 2014*). Many references to barley and beer are found in early Egyptian and Sumerian writings those are more than 5000 years old. Archaeological evidence of barley cultivation dates back to 8000 BC in Iran. There is now considerable evidence that the initial cultivation of barley in China and India occurred at a later date. Cultivable barley is one of the 31 Horedum species, belonging to the tribe *Trtiticeae*, of family *Poaceae* (*Verma et al. 2005*). Barley is cultivated since ancient times (7500 BC) and mostly being used as cattle feed and also utilised for human consumption (*Meena et al. 2011*) as a major cereal crop primarily grown for its grain, but it also yields valuable forage that can be grazed, cut for hay or silage while still green or cut after grain harvest as straw. Barley can be utilized as a source of green fodder in rainfed, arid to semiarid conditions where other water loving crops like barseem, oats, sugarcane etc. cannot be grown due to water shortage (*Kharub et al, 2013*). Generally, it is considered important for livestock feeding, which accounts for about 85per cent of barley production. It is one of the coarse grains like corn, oats and sorghum. A coarse grain generally refers to cereal grains other than wheat and rice. Traditionally considered as a poor man's crop, barley in India is favoured because of its low input requirement and better adaptability to harsh environments, likely drought, salinity /alkalinity and marginal lands. In India, its utilization as food crop (mainly hull less type) is restricted to the tribal areas of hills. The barley products like "Sattu"

(in summers because of its cooling effects on human body) and Missi Roti have been traditionally used in India (*Verma et al.2011*). In north Indian hills, barley is the main staple food crop in the tribal areas. It is also utilised in preparation of the local beverages in addition to cattle feed. Barley has the potential to be utilised as a green fodder under water scarcity conditions, as it is very fast growing crop with high biomass in the early stages and requires less water (*Verma et al. 2005*). It is, is grown during winter season (rabi) in the northern plains as well as in northern hills, mostly under rainfed or limited irrigation condition on poor to marginal soils.

In the hilly region of Uttarakhand, India both in the irrigated and rainfed areas, the predominant system of agriculture is mixed crop-livestock farming. The farmers, mostly marginal, mainly depend on forest resources to feed their livestock. This sometimes contributes to degradation of forests in certain areas, particularly in the lean periods (summer and winter). But it is found that in the same regions some of the farmers cultivate barley (*Hordeum vulgare*) for fodder purpose (use of grain for human consumption was an earlier practice but discontinued later, despite being highly nutritious). To catalyse the process awareness needs to be created among people to resume the use of barley grain as human food considering its nutritional value. Hence it is very clear that large scale promotion of dual purpose barley as a food-feed crop in the hills of Uttarakhand, can help addressing the fodder shortage issue (in the lean periods), reduce dependence on forest, increase food security as well as the improved lines of barley could be valuable feed resources that could fit well in the feeding calendar for the winter months especially in hilly areas where other feed resources are scarce.

Central to the challenge of feed scarcity in hills of Uttarakhand, trials were conducted in Uttarakhand India to to compare the local barley variety with a dual purpose variety *Pusa Lohar* or BHS 380 on fodder and grain yield under different fertiliser management. The data was analysed using were statistically analysed using mean and standard error as per standard procedure (*Snecdecor and Cochran 1994*) and Statistical analysis carried out by General Linear Models (GLM) procedures using SAS (9.2) to draw meaningful conclusion.

METHODOLOGY

The experiment was conducted at farmers' fields in village Kothera and Thaeli of a northern state Uttarakhand of India. To understand the response of green fodder harvest at 75/80 days after sowing (DAS) ,the trial was carried out with two varieties - local barley variety (the name not known by the farmers) and improved variety- named *Pusa Lohar* or BHS 380 in complete randomised block design with plot size of 2m2 with four treatments and four replications:

i. No cut; no fertiliser
ii. Cut at 75/80 DAS; no fertiliser
iii. Cut at 75/80 DAS with 100 kg urea (46 kg N^{-ha}) after the cut
iv. Cut at 75/80 DAS with 6 tFYM -ha after the cut.

The crop was sown (seed rate 100 kg/ha) in the first location (Tehri Garhwal) on Nov. 7, 2011 by broadcasting (local variety) and using a seed drill (BHS 380). Three irrigations were given by the farmer: first during 2-3 days after sowing, second on 60 DAS and third on 76 DAS. As per treatments, harvesting of crop for fodder was done at 75 DAS leaving a stubble height of 5 cm. The final harvest was done at 165 DAS. In Pithoragarh the seeds were sown (broadcasting) on December 2, which was late by 47 days compared to the normal sowing season (mid October) because farmer has other important priorities like marriage in his family and fodder was harvested at 80 DAS. Here, one irrigation was given at 82 DAS. Final harvest was done at 159 DAS. 100 kg urea (46 kg N^{-ha}) was applied within 10 days of sowing and after the defoliation in the selected plots was applied. While in plots with FYM treatment 6 t FYM-ha after the cut was applied. Barley crop was cut before nodule formation in the plant at 5 inch above the ground in both the sites. Observations were recorded using a quadrate of 0.25/ m^2 at three places from a plot. Non destructive observations like-number of barley plant /m^2, plant height and number of tillers/m^2 was recorded. Destructive observations like-green fodder yield, average number of grain /spike, average gram 1000 grain weight, total biomass was recorded. The data was analysed using were statistically analysed using mean and standard error as per standard procedure (*Snecdecor and Cochran 1994*) and Statistical analysis carried out by General Linear Models (GLM) procedures using SAS (9.2) to draw meaningful

conclusion. Feed samples were collected, pooled and chemically analysed for proximate principles as per Association of Official Analytical Chemists (*AOAC, 1995*) for nutritive evaluation.

RESULTS AND DISCUSSION

Non-destructiveand destructive observations at the trial sites after sowing: It was observed in Tehri Garhwal district at 75days after sowing that average number of plants/m^2 in BHS 380 ranged 104 to 120vs in local variety 85 to 134, the number of tillers/m^2 376to 418in BHS 380 vs274 to 367 in local. Average plant height of in local barley ranged from 18.95 to 22.28 cm while in case of BHS 380 it ranged between 27.7 cm to30.28 cm. Similar to this in field site Pithoragarh, at 80 days after sowing it was observed that the number of plants and plant height were more in the BHS 380than the currently cultivated local one. But average plant height and green fodder yield was more in the local variety. The average number of plants/m^2 ranged between (742 to 1040) in local barley was less than BHS 380 (918 to 1085). In BHS 380 the number of tillers/m^2 ranged 1001 to 1300 while 903 to1211 in local. Average plant height in BHS 380 was in range of 18.25 to21.62 cm less than local barley 19.26 to 22.13 cm. Analysis from the two regions suggest that in Tehri Garhwal the mean average green fodder yield from local barley variety (2.02 t^{-ha}) was less than that of BHS 380 (3.67t^{-ha}) while in case of Pithoragarh, the mean average green fodder yield from local barley variety (1.8t^{-ha}) was more than that of BHS 380 (1.49t^{-ha}). These variations could be because of different soil and agro-climatic conditions.

Non-destructive and destructive observations at the trial sites at the time of harvest: In district Tehri Garhwal at 165 days after sowing, average plant height in local variety ranged from (87 to 92.2 cm) which was more than BHS 380 (73.58 to 78.58 cm). The spike length ranged from 5.8 to6.68 cm in local and 3.5 cm to 3.75 cm in BHS 380. Number of tillers/m2 (439 to 494) in BHS 380 was more than the local (327 to 435) variety. In Tehri Garhwal, it was found that the plant height, spike length and number of tillers in the local variety did not change much when fodder was cut and FYM was applied. With urea application, though the plant height and spike length reduced slightly, the number of tillers increased by 37 per cent. When fodder is cut and no fertiliser /manure was applied all the three factors reduced to some extent. In the case of BHS 380, there was not much change in plant height, spike length and number of tillers when fodder was cut with and without urea /FYM application. In the local variety the number of grains per spike and 1000 grain weight reduced slightly when fodder was cut with and without fertilizer /manure application But the reduction was less when urea was applied after fodder harvest.

In case of Pithoragarh, 159 days after sowing, average plant height in local variety ranged from (61.02 to 65.17 cm) which was more than the BHS 380 (55.48 to 57.11 cm). The spike length ranged from 4.88 to 5.72cm in local was more than BHS 380 (4.72 to 5.2 cm). Number of tillers/m^2 (1084 to 1343) in local variety was less than BHS 380 variety (1115 to 1391). In the local variety it was found that while the plant height and number of tillers increased in all the treatments, the spike length got reduced in all cases. In the case of BHS 380, there was not much change in plant height, spike length and number of tillers except in the case of FYM application, which resulted in an increase of spike length by 10 per cent and number of tillers by 25 per cent. In the local variety the number of grains per spike, 1000 grain weight and total biomass increased in all the treatments with maximum effect when no urea /FYM was applied followed by cut with urea and cut with FYM application (with the exception of reduction in 1000 grain weight with FYM application). In the improved variety the total biomass increased with urea application, grains per spike increased with FYM application and 1000 grain weight increased with urea and FYM application.

Impact of fodder harvest on grain and straw yields in Tehri Garhwal and Pithoragarh: Statistical analysis revealed that in Tehri Garhwal (between varieties there is significant difference in fodder, grain and straw yield (BHS 380). In Pithoragarh, between varieties there is significant difference in grain and straw yield (BHS 380) but the difference is not significant for green fodder production (Table 1).

As far as the treatments are concerned in Tehri Garhwal (Table 2), BHS 380 variety produced maximum quantity of grains when urea was applied (4.78 t^{-ha}). In the local variety also, though insignificant, maximum grain yield was noted when urea was applied after fodder harvest.

Table 1 Impact of varieties on green fodder, grain & straw yield

Varieties	Tehri Garhwal			Pithoragarh		
	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})
Local variety	2.01	3.74	5.81	1.80	4.77	5.34
BHS 380	3.67	4.44	7.59	1.50	6.99	14.19
Overall mean*	2.84	4.09	6.70	1.65	5.88	9,76
Probability (P)	0.0006	0.0001	0.004	0.23	0.008	<0.0001
LSD	0.84	0.26	1.16		1.59	2.78

If P< 0.05, significant at 5per cent level of significance; P>0.05, NS; *(across treatments including no cut)

Table 2. Impact of treatments on green fodder, grain & straw yield

Treatments	Tehri Garhwal						Pithoragarh					
	Local Variety			BHS 380			Local variety			BHS 380		
	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})	Fodder (t^{-ha})	Grain (t^{-ha})	Straw (t^{-ha})
Cut; Urea	1.76	3.89	5.97	3.78	4.78	7.31	1.66	4.86	6.16	1.01	6.84	15.4
Cut; FYM	2.71	3.69	5.75	3.62	4.11	7.81	1.87	5.4	4.98	2.20	5.84	14.03
Cut; No Urea/FYM	1.59	3.55	5.72	3.62	4.5	7.47	1.89	6.2	5.5	1.28	7.23	13.80
Overall mean*	2.02	3.71	5.81	3.67	4.46	7.52	1.80	5.48	5.54	1.50	6.63	14.40
Probability (P)	0.004	0.55	0.98	0.98	0.04	0.88	0.87	0.74	0.88	0.02	0.60	0.79
LSD	0.6				0.51					0.83		

If P< 0.05, significant at 5 per cent level of significance; P>0.05, NS; *(across treatments excluding no cut)

Table 3. Selection of variety and treatment – the decision matrix

Tehri Garhwal			Pithoragarh		
The present Local variety yields →	No fodder	3.83 t grain* 5.84 t straw*	The present Local variety yields →	No fodder	2.62 t^{-ha} grain* 4.71t^{-ha} straw*
Local variety yields when cut at 75 DAS →	1.76 t^{-ha} fodder	Application of urea FYM will produce 3.89 t^{-ha} grain and 5.97 t^{-ha} straw	Local variety when cut at 80 DAS →	1.89 t^{-ha} fodder	No. application of urea /FYM will produce 6.20 t^{-ha} grain and 5.50 t^{-ha} straw
Improved variety BHS 380 when cut at 75 DAS →	3.78 t^{-ha} fodder (significant)	Application of urea (best treatment) will produce 4.78 t^{-ha} grain and 7.31 t^{-ha} straw (significant)	Improved variety BHS 380 when cut at 75 DAS →	1.28 t^{-ha} fodder	No application of urea /FYM (best treatment) will produce 7.23 t^{-ha} grain and 13.80 t^{5t} straw (significant)

As far as the treatments are concerned (Table 2) the BHS 380 produced maximum quantity of grains when no urea or FYM is applied (7.23 t^{-ha}), followed by application of urea after cut (6.84t^{-ha}). The local variety is also found to produce maximum grains when no urea/ FYM was applied after fodder harvest.

The following Table 3 summarises the analysis and helps us to take a decision on the desirable variety in Tehri Garhwal and Pithoragrh through a comparison of impact on grain and straw yield with and without fertiliser /manure application after fodder harvest at 75 and 80 DAS respectively. Between the two varieties, BHS 380 is the one that can be recommended as it produces substantially higher quantities of grains and straw besides 1.28 to 3.78 t^{-ha} of green fodder during lean season. Under normal sowing BHS 380 gives higher green forage, and under delayed sowing in December, as observed in Pithoragarh, too it yielded green fodder.

Table 4. Chemical composition of local barley (LB) and BHS 380 from the trial sites

	Average*				
	DM%	EE%	CP%	CF%	AIA%
LB – GF	76.56	2.64	21.70	22.04	2.01
LB– Straw	9.12	2.86	22.77	22.58	1.75
LB – Seed	12.91	3.09	10.63	11.23	0.60
BHS-380 -GF	76.29	2.45	23.10	21.96	1.97
BHS-380-Straw	7.58	2.76	23.33	22.68	2.01
BHS 380– Seed	12.03	3.83	10.60	10.95	0.67

**DM=Dry Matter; EE=Ether Extract; CP=Crude Protein; CF=Crude Fibre; AIA=Acid Insoluble Ash; Values are on DM basis except for dry matter; GF=Green fodder*

Chemical composition and nutritional evaluation: Nutrient contents of feeds and fodders greatly vary due to: soil composition, effect of manure and fertiliser, irrigation, stage of growth, frequency of cutting and variety and strain of feed resources (*Upreti et al 2006*).The chemical composition of local and BHS 380 - green fodder, straw and seed on percent dry matte basis is presented in Table 4. Barley forage has a highly variable composition, depending on maturity stage, climate and other parameters. Protein is an important nutrient required to the animal. The result shown below indicates that crude protein was less in local variety of barley (21.70%) in comparison to BHS 380 (23.10%) on dry matter basis.

CONCLUSION

It can be concluded that, both in Tehri Garhwal and Pithoragarh, the improved variety BHS 380 performed better in terms of fodder, grain and straw yields. The performance in terms of grain and straw yield was commendable in Pithoragarh compared to Tehri Garhwal. While the best treatment to get best results (from the improved variety) In Tehri Garhwal was 'application of urea after fodder cut', that in Pithoragarh was 'no application of urea /FYM' response to urea is masked by delayed sowing and shorter available growing period.

Hence timely sowing for the dual purpose barley is required for optimum forage, grain and straw production from barley. Production of green fodder and utilisation of stuff are two sides of the same coin. Therefore, quality livestock feeding can be done by producing more and better utilising of available dual purpose crops to reduce costs and for increase milk production.

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