

Original Research Article

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Effect of Nutrient Sources on Nutritional Quality of Barley (*Hordeum vulgare* L.)

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ABSTRACT

The micro pot experiment was conducted to know the effect of nutrient sources on nutritional quality of Barley (*Hordeum vulgare* L.). Highest nutritional quality were computed in N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ (T₅) and lowest in absolute control in different cultivars of barley. The nutritional quality of all the nutrients increased with an increase in graded levels of fertilizers with integration of FYM. On an average highest nitrogen content were recorded with combination of FYM 5 t ha⁻¹ along with graded levels of nutrients i.e. N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ (T₅) were found highest 1.63% in Haritima V₁ and 1.71% in Azad v₂ in comparison to lowest nitrogen contents were recorded in absolute control. Similarly, without integration of FYM highest nitrogen content 1.56% was observed in Haritima V₁ and 1.67% in Azad v₂ in comparison to control (T₁). The integrated use of nutrients also significantly increased nitrogen, phosphorus, potassium, sulphur and zinc content in grains and straw of Barley. It can be inferred that highest nutritional quality in barley cultivars could be achieved with integrated use of organic manure (FYM) and inorganic fertilizers N, P, K, S and Zn. The treatment N₈₀ P₅₀ K₅₀ S₄₀ Zn₅ kg ha⁻¹+FYM @ 5 t ha⁻¹ came out to be best dose for maximum nutrient content.

Keywords

Barley (*Hordeum vulgare* L.), FYM, Fertilizers, Nutritional quality

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Introduction

Barley is one of the most important crops of the world and is cultivated over almost all parts of the world except tropical region. It was considered to be the first ever cereal crop to be domesticated. It is available in a variety of forms like whole barley, hulled barley, pearled barley as well as barley flakes. Along with Emmer wheat, low yielding owned wheat,

barley was a staple food crop of ancient Egypt, dating back to as far as 5000 BC as ever earlier than that. At that time the main use of barley was limited to making beer and bread. It is a rich source of metals like zinc, copper, phosphorus, calcium and iron.

Barley is the world's most nutritional crop and is recommended for children during their growing stage. This is because barley contains many elements that are rich sources of health

and energy. The composition of barley, excluding the percentage of salt, gives a general idea about its uses in everyday life. Barley contains about 15% water, 12.98% of nitrogenous compounds, 6.74% of gum, 3.2% of sugar, 60% (approx) of starch and 2.2% fat. Being a good source of protein, it is used as a feed for the livestock. The barley used as an animal feed is rolled, grounded, flaked or polluted. These products are given in the form of grain, silage, or straw to dairy and beef cattle. The byproducts of malted barley are also used in the form of animal feed. A wide variety of barley products are known to be suitable for human consumption. These includes porridge, muesli, cookies etc. made of barley flakes, cereals made of barley bran and muffins, cookies, breads, pasta, made of barley flours etc. Apart from being used as an eatable, barley is also used in many other fields like industries and agriculture. The barley straw is used to make the bed for the livestock, while bales of barley are used in making paper, fiber board etc. The starch present in barley is used in making paper starch based detergents, bio-degradable plastics etc.

Among the entire essential nutrient element required by plants, FYM and Inorganic fertilizer plays a vital role in growing the crops satisfactory. FYM and inorganic fertilizers are the main source of nutrients. It influences plant growth in two ways, firstly by acting as nutrient and secondly by improving the soil condition. As a soil amendment, FYM may affect the availability of nutrient element in several ways by improving the physical condition of soil. It ranks in importance with nitrogen and phosphorus in the formation of protein.

At present, it is being realized that continued cultivation of exhaustive crops like cereals has caused heavy depletion of the nutrient and if not replenished regularly and adequately the

situation may get aggravated with the adoption of new high yielding varieties on a large scale.

The use of inorganic fertilizer like urea, DAP, MOP and ammonium phosphate in heavy amount to meet the N, P and K requirement of cereals like barley, has further exhausted the soil fertility especially micro nutrient elements and organic carbon. Thus, absorption of macro nutrient element and organic carbon by crops in huge amounts and use of inorganic fertilizer and FYM fill its deficiency in soil and plant and created nutrient balance in soil plant system. FYM and inorganic fertilizer is one of the most important inputs in agriculture. Efficient use of FYM and inorganic fertilizer in proper dose depends on suitable method of application, agronomic practices, nature of soils and crops etc. It is well known fact that almost all soils are deficient in nitrogen. Thus, to obtain maximum yield and nutritional quality from crop in a particular tract, it is essential to determine the best possible dose of FYM along with inorganic fertilizer. Keeping all above facts in view, the present study has been undertaken to study the effect of nutrient sources on nutritional quality of Barley (*Hordeum vulgare* L.).

Materials and Methods

Experimental detail

The present experiment was conducted at micro pot culture house of the Department of the Soil Science and Agriculture Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *Rabi* 2009-10. This site is situated in the alluvial belt of gangetic plain in central UP and sub-tropical zone. It falls in the altitude and longitude range of 79.31° and 80.34°E and 25.26°N, respectively. The mean elevation of far from sea level is 125.90 meters. The experimental site is characterized by semi and subtropical climate with hot dry summer and

cold winters. The mechanical composition and physico - chemical characteristics of the soil are given in Table 1. The barley variety used in the present experiment is Haritma (K-560) and Azad. The experiment was conducted in randomized block design with 3 replications in 8 treatment combination (Table 2).

The spacing of 22 cm between row to row and 5 cm plant to plant was maintained. The seed were placed at about 4 cm depth. The crop was rain fed and total 3 irrigations were given at different intervals. First irrigation was given at active tillering stage and second at flowering and third at milking stage. The all recommended agronomic packages and practices were done timely to raise good crop stand. As per treatment, different doses of FYM and inorganic fertilizer were applied with gypsum source at the 7 days before sowing. Total amount of phosphorus and potash and half of the nitrogen were applied at the time of sowing; remaining half dose of nitrogen was top dressed at the time of first irrigation. Composition of inorganic fertilizer used is presented in Table 3.

Preparation of plant sample

Plant sample (grain and straw) were taken after harvesting of the crop and these samples were first air dried under shade and then kept in an oven at 65°C for 8 hours to become free from moisture. The oven dried samples were ground by Willey Stainless Steel Mill and stored in the sampling bottles.

Data collection

The observations recorded are grain yield (q ha⁻¹), straw yield (q ha⁻¹), number of tillers per plant, plant height (cm), 1000 grain weight (g), nutrient (N, P, K, S and Zn) content and uptake in grain and straw, protein content and uptake in grain and straw.

Soil analysis

Mechanical analysis was done by international pipette method as described by Piper (1966). Soil pH was measured in 1:2.5 soil water suspensions by Electro digital pH meter.

Electrical conductivity in soil water suspension (1:2.5) was determined by conductivity meter. For organic carbon Walkley and black's rapid titration method was used and available potash was extracted in normal ammonium acetate (NH₄OC, pH 7.0) solution and determined flame photometrically as described by Jackson, (1967). However, available nitrogen was determined by alkaline potassium permagnate method as described by Subbiah and Asija, (1956). Phosphorus was extracted by olsen's method, 1954 and amount of available phosphorus in the extract was determined calorimetrically by vanadate molybdate method (Jackson, 1967).

Plant analysis

Nitrogen in plant was determined by micro Kjeldahl's method as described by Piper, (1966). For phosphorus ground seed and straw samples were digested in a diacid mixture of HClO₄ (4:1) and P concentration in the extract was estimated by method as described by Chapman and Pratt, (1961). Potassium concentration in the diacid extract was determined by flame photometrically as per procedure given by Black, (1965). Uptake of FYM and inorganic fertilizer (N, P, and K) at harvest stage (seed and straw) were obtained by multiplying dry matter yield at this stage with concentration of these nutrients.

Statistical analysis

The mean performance of individual genotypes in different treatment combinations was employed for statistical analysis. The statistical procedure was adopted as described

by chandel (1975).

Results and Discussion

Effect of nutrient sources on nutritional quality of Barley (*Hordeum vulgare* L.) obtained and salient features have been described in following heads:

Nitrogen content

Nitrogen contents increased in linear order with increasing the level of organic and inorganic fertilizers (Table 4 and Fig. 1.). Highest nitrogen content in grain was observed 1.63 per cent in V₁ and 1.71 per cent in V₂ with treatment full dose of fertilizers with organics N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ and FYM 5 ton ha⁻¹(T₅). Whereas in absolute control 1.36 per cent in V₁ and 1.41 per cent in V₂ fertilizers.

It is very interest to mention here that nitrogen contents were more with the treatment (N₈₀, P₅₀, K₅₀ and FYM 5 t ha⁻¹) alone, in comparison to treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹, full dose of fertilizers without organic manure.

The nitrogen content in grain differed significantly with all the treatments. In case of without organic application highest nitrogen content inorganic was observed with the treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ in experimental treatment (N₈₀, P₅₀, K₅₀).

However, highest nitrogen content in straw was recorded with treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with organic manure in all the cultivars (0.51 in V₁ and 0.56 in V₂) and lowest in absolute control. Likewise highest nitrogen contents recorded without FYM treatment with full dose of fertilizers i.e. (N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹) 0.50 in V₁ and 0.53 in V₂ in comparison to absolute control.

Phosphorous content

The highest phosphorous content were recorded in the treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ and FYM 5 t ha⁻¹ (T₅) 0.38 per cent in V₁ and 0.41 per cent in V₂ in comparison to absolute control i.e. 0.25 per cent in V₁ and 0.27 per cent in V₂ with the integration of organic manure (Table 4 and Fig. 2).

Similarly highest P content were recorded in treatment T₈ (N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹) 0.34 per cent in V₁ and 0.37 per cent in V₂ in comparison to absolute control without integration of FYM. However, highest P content was noted 0.095 per cent in cultivar in V₁ and 0.098 per cent in V₂ in comparison to absolute control i.e. 0.079 per cent in V₁ and 0.081 per cent in V₂ with integration of FYM, whereas highest contents 0.09 per cent in V₁ and 0.091 per cent in V₂ without integration of FYM in comparison to absolute control in all the cultivars.

Potassium content

The highest K content were noted in the treatment T₅ (N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹) 0.40 per cent in V₁ and 0.44 per cent in V₂ and lowest in absolute control i.e. 0.22 per cent in V₁ and 0.24 per cent in V₂. Without integration of organics highest K content were noted 0.38 per cent in V₁ and 0.40 per cent in V₂ comparison to all the treatments (Table 4 and Fig. 3).

However, the highest K content were recorded with application of treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ and FYM 5 t ha⁻¹ (T₅) 1.72 per cent in V₁ and 1.81 per cent V₂ in comparison to absolute control i.e. (1.38 per cent in V₁ and 1.42 per cent in v₂). Likewise, highest content were noted without organics 1.67 per cent in V₁ and 1.72 per cent in V₂ in treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ (T₈).

Sulphur content

Sulphur content was significantly influenced by graded levels of inorganic fertilizers with and without FYM (Table 4 and Fig. 4). With increasing the dose of fertilizers with and without FYM sulphur content also increase the significantly and linearly. Sulphur content were recorded highest in the treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ and FYM 5 t ha⁻¹ (T₅) 0.134% in V₁ and 0.142% in V₂ cultivar in comparison to absolute control (i.e. 0.087 % in V₁ and 0.910% in V₂).

It is very interest mention here that combination of full dose of fertilizer with FYM the level of sulphur content more (0.106% in V₁ and 0.113% in V₂) in comparison to full dose of fertilizers without FYM (i.e. 0.094% in V₁ and 0.099% in V₂). However, the highest sulphur content was recorded with the application of full dose of fertilizers in combination of organic 0.09% in V₁ and 0.106% in V₂ in comparison to absolute control i.e. 0.061% in V₁ and 0.650% in V₂. with the application of N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ without combination of FYM the sulphur content were recorded more i.e. 0.083% in V₁ and 0.090% in V₂ in comparison to control.

Zinc content

The highest value of Zn were noted in the treatments N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ and FYM 5 t ha⁻¹ (T₅) 52.90 ppm in V₁ and 60.70 ppm in V₂ in comparison to absolute control i.e. 16.50 ppm in V₁ and 18.30 ppm in V₂. Similarly highest value of Zn content were obtained in the treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ without FYM 43.8 ppm in V₁ and 45 ppm in V₂ in comparison to absolute control i.e. 16.5 ppm in V₁ and 18.3 ppm in V₂ (Table 4 and Fig. 5). However, the highest Zn content was noted in straw with increasing the graded levels of fertilizers with and without FYM. The highest Zn content were recorded

with full dose of fertilizers in the combination of FYM i.e. 47.20 ppm in V₁ and 50.70 ppm in V₂ in comparison to absolute control i.e. 14.40 ppm in V₁ and 15.60 pp in V₂

Impact of nutrient sources on nutritional quality of Barley (*Hordeum vulgare* L.) showed that the effect of addition of graded levels of fertilizer with and without FYM on nutrient content i.e., nitrogen, phosphorous, potassium, sulphur and zinc were determined in plants at maturity stage. Nitrogen content increased in the linear order with increase the graded levels of fertilizers being highest in N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ (t₅) and lowest in absolute control. Similarly N content was also recorded highest on the addition of graded levels of fertilizers without FYM. These results are supported by of findings of Chaudhary *et al.*, (2003).

The data revealed that phosphorous content increased significantly with increased graded level of fertilizers with and without FYM. These results are line with the findings of Sitaramya (2009) and Hitesh *et al.*, (2010). The potassium content is increased with an increase graded levels of nutrients highest at treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ (t₅) and lowest at absolute control (T₁). The straw has higher concentration of potassium than grain. Potassium is the highest parts of meristematic tissues and essential for carbohydrate metabolism in the vegetative organs of plants (Tisdale *et al.*, 1995.).

The sulphur content increased continuously with an average levels being highest N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ (t₅) and lowest at absolute control (T₁). The increase in sulphur content in present study is supported by the various research workers (Astalfi *et al.*, 2010; Grzebisz and Przygockacyna 2007).

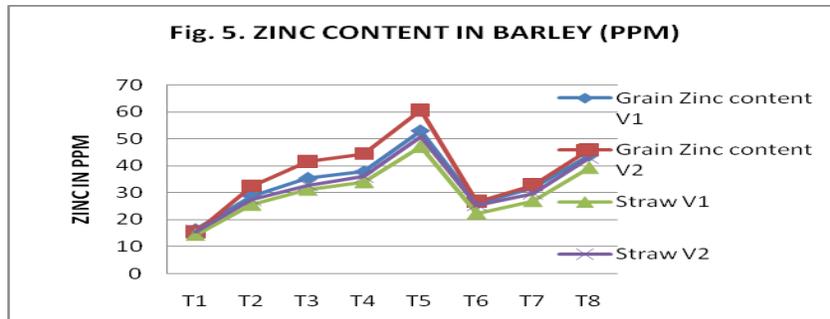
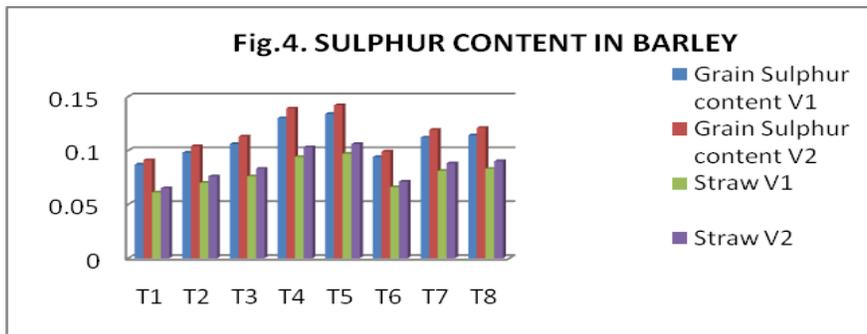
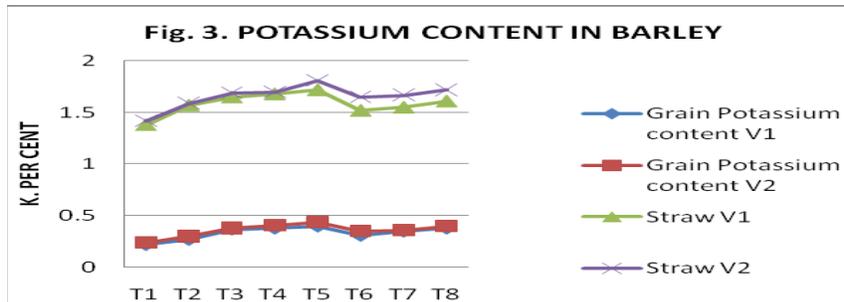
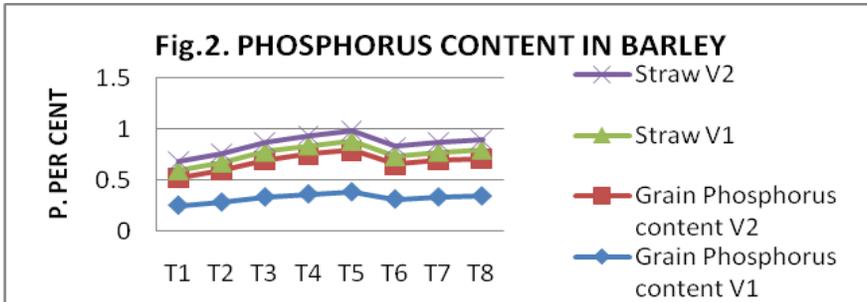
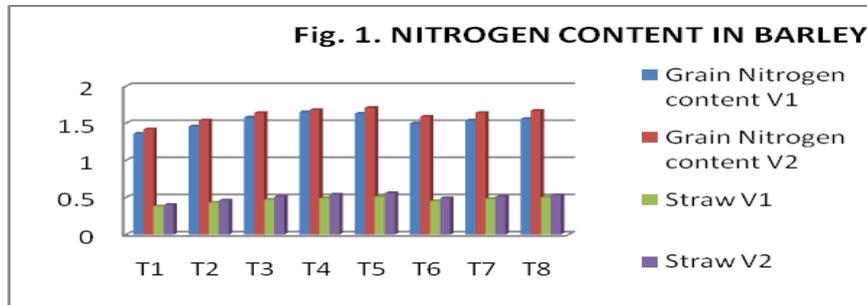


Table.1 Some important physico–chemical properties of experimental soil

Sr. No.	Soil characteristics	Value
A	Mechanical separates	
1	Sand (%)	26.70
2	Silt (%)	49.70
3	Clay (%)	23.40
B	Physico – chemical characteristics	
1	pH	7.6
2	Electrical conductivity (dSm ⁻¹)	0.265
3	Organic carbon (%)	0.32
4	Available nitrogen (kg ha ⁻¹)	185.0
5	Available phosphorus (kg ha ⁻¹)	9.5
6	Available potassium (kg ha ⁻¹)	182.0
7	Available Sulphur	132.0
8	Available Zinc	0.40ppm

Table.2 Different treatment combination used in the experiment

Treatment	Treatment combination
T ₁	Absolute control
T ₂	Control (FYM @ 5 t ha ⁻¹)
T ₃	N ₈₀ , P ₅₀ , K ₅₀ kg ha ⁻¹ , FYM @ 5 t ha ⁻¹)
T ₄	N ₈₀ , P ₅₀ , K ₅₀ , S ₄₀ kg ha ⁻¹ , FYM @ 5 t ha ⁻¹)
T ₅	N ₈₀ , P ₅₀ , K ₅₀ , S ₄₀ , Zn ₅ kg ha ⁻¹ , FYM @ 5 t ha ⁻¹)
	Without FYM
T ₆	N ₈₀ , P ₅₀ , K ₅₀ kg ha ⁻¹
T ₇	N ₈₀ , P ₅₀ , K ₅₀ , S ₄₀ kg ha ⁻¹
T ₈	N ₈₀ , P ₅₀ , K ₅₀ , S ₄₀ , Zn ₅ kg ha ⁻¹

Table.3 Composition of inorganic fertilizer used in the experiment

Nutrient applied	Source	Percentage nutrient
Nitrogen	Urea	46 % N
Phosphorus	DAP	18 % and 46 % P ₂ O ₅
Potash	MOP	60 % K ₂ O
Sulphur	E Sulphur	95% S
Zinc	ZnCl ₂	48% Zn
FYM	FYM	0.5% N, 0.25%P, 0.5% K

Table.4 Effect of organic and inorganic fertilizers on N, P, K, S and Zn content in grain and straw of different cultivars of barley

Treatments	Grain		Straw		Grain		Straw		Grain		Straw		Grain		Straw		Grain		Straw	
	Nitrogen content				Phosphorus content				Potassium content				Sulphur content				Zinc content			
	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂
T ₁	1.36	1.42	0.38	0.4	0.25	0.27	0.079	0.081	0.22	0.24	1.38	1.42	0.087	0.091	0.061	0.065	16.5	15.3	14.4	15.6
T ₂	1.46	1.54	0.43	0.46	0.28	0.31	0.085	0.087	0.27	0.3	1.57	1.59	0.098	0.104	0.07	0.076	28.8	32.5	25.6	27.4
T ₃	1.58	1.64	0.47	0.51	0.33	0.36	0.09	0.093	0.37	0.38	1.65	1.69	0.106	0.113	0.076	0.083	35.4	41.6	31.2	32.7
T ₄	1.65	1.68	0.49	0.54	0.36	0.39	0.091	0.096	0.38	0.41	1.68	1.70	0.13	0.139	0.094	0.103	37.8	44.5	34	36
T ₅	1.63	1.71	0.51	0.56	0.38	0.41	0.095	0.098	0.4	0.44	1.72	1.81	0.134	0.142	0.097	0.106	52.9	60.7	47.2	50.7
Without Farm Yard Manure (FYM)																				
T ₆	1.50	1.59	0.45	0.49	0.31	0.34	0.087	0.09	0.31	0.35	1.52	1.65	0.094	0.099	0.066	0.071	26	26.8	22.4	25.4
T ₇	1.54	1.64	0.48	0.51	0.33	0.36	0.089	0.092	0.35	0.36	1.55	1.67	0.112	0.119	0.081	0.088	31.9	32.9	27	29.7
T ₈	1.56	1.67	0.5	0.53	0.34	0.37	0.09	0.091	0.38	0.4	1.61	1.72	0.114	0.121	0.083	0.9	43.8	45.9	39.3	42.8
SE±	0.01	0.01	0.01	0.1	0	0.01	0.0005	0.0005	0.01	0	0.01	0.01	0.009	0.01	0.008	0.001	1.06	1.21	1.34	1.44
CD at 5%	0.02	0.03	0.02	0.02	0.01	0.01	0.0009	0.001	0.02	0.02	0.02	0.03	0.002	0.002	0.002	0.002	2.12	2.4	2.67	2.84

*V₁= Haritma, V₂= Azad.

Highest nutrient concentration of zinc was observed with the application of graded levels of fertilizers with and without FYM. The highest value of zinc concentration was noted in the treatment N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 ton ha⁻¹ followed by N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ without FYM. These results are in line with the findings of Sharma and Bapat (2000), Pareta *et al.*, (2009) and Singh and Tripathi (2008). It is also apparent from the data that grain contents higher nitrogen, phosphorous, sulphur than straw whereas straw has higher potassium than grain. The higher content is due to translocation of nutrients from the vegetative parts of the plants to grain at the time of maturity (Chahal *et al.*, 1979).

Potassium is an essential for promoters of meristematic tissues (Tisdale *et al.*, 1995). Therefore, it is not translocated from vegetative parts to seeds and hence higher concentration of potassium in straw than grain in present study possible. The addition of graded levels of fertilizers with and without combination of FYM influenced the uptake of nitrogen, phosphorous, potassium, sulphur and zinc significant levels. It is apparent that with increase in doses of graded levels of fertilizers in combination with uptake of above nutrients increased in linear order in both grain and straw. The uptake of nitrogen, phosphorous, potassium, sulphur and zinc in both grain and straw is parallel to N, P, K, S and Zn contents of fertilizers in combination with and without FYM.

The total content of these nutrients increased in linear order with increase in graded levels of fertilizers with and without FYM. The highest content of nutrients were computed at (T₅) treatment i.e. N₈₀, P₅₀, K₅₀, S₄₀, Zn₅ kg ha⁻¹ with FYM 5 t ha⁻¹. Content of nutrients are more with the integration of FYM in the similar inorganic fertilizers treatments. Nitrogen content in grains was significantly

influenced by different treatments. It is also interesting mention here with the application of FYM similar treatments of graded levels of fertilizers the nitrogen contents is more in case of without FYM application.

From the experimental findings it can be inferred that highest content of nutrients in barley cultivars could be achieved with integrated use of organic manure (FYM) and inorganic fertilizers N, P, K, S and Zn. The best treatment combination in the study obtained was N 80, P 50, K 50, S 40; Zn 5 kg ha⁻¹ combined with FYM @5 tha⁻¹ (T₅).

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