International Journal of Agricultural Sciences
Volume 8 |Issue 1| January, 2012 | 91-97

RESEARCH PAPER

Effect of varieties and integrated nutrient management techniques on growth, productivity, quality and economics of barley (*Hordeum vulgare* L.)

HARI RAM AND S.S. DHALIWAL
Department of Agricultural Meteorology, Punjab Agricultural University, LUDHIANA (PUNJAB) INDIA
(Email : dhaliwal1969@yahoo.com)

Abstract **:** A field experiment was conducted at Punjab Agricultural University, Ludhiana during for two consecutive years (2007-08 to 2008-09) to study the effect of integrated nutrient management on growth, productivity, quality and economics of barley. The experimental site (30° 56'N, 75° 52'E; 247 m ASL), was having deep alluvial loamy sand, low in organic carbon (3.4 g C kg^{-1}) and slightly alkaline (pH 7.5). The region has a sub-tropical climate having cool and dry winters during the crop season. The experiment was conducted in factorial randomized block design with two cultivars of barley (DWRUB 52 and RD 2552) and integrated nutrient management treatments [RDF (90 kg N, 30 kg P_2O_5 and 20 kg K_2O/ha), 75 per cent RDF + FYM (5t/ha), 50 per cent RDF + FYM (5t/ha), 75 per cent RDF + FYM (5t/ha) + biofertilizer, 50 per cent RDF + FYM (5t/ha) + biofertilizer, 100 per cent fertilizer through FYM + biofertilizer and absolute control] with three replications. The grains per ear were significantly higher in RD 2552 than DWRUB 52. Both the varieties *i.e.* DWRUB 52 and RD 2552 recorded the similar grain yield and economics. All nutrient management techniques recorded significantly higher grain yield than absolute control. The highest productivity was recorded in 75 per cent RDF + FYM in 2007-08 and in 75 per cent RDF + FYM + biofertilizer in 2008-09 which was statistically at par with RDF and 75 per cent RDF + FYM + biofertilizer in 2007 and 75 per cent RDF + FYM treatments in 2008-09 but significantly higher than rest of the treatments. These manures along with RDF also helped in increasing the DTPA-extractable Zn, Cu, Fe and Mn in the soil. The highest gross returns, net returns, and B:C ratio were recorded in 75 per cent RDF + FYM treatment in 2007-09 and in 75 per cent RDF + FYM + biofertilizer treatment in 2007-09. It might be due to higher grain yield and lower variable costs recorded in these treatments.

Key Words **:** Barley malt varieties, Bio fertilizer, Economics integrated nutrient management, Productivity, Quality

View Point Article **:** Ram, Hari and Dhaliwal, S.S. (2012). Effect of varieties and integrated nutrient management techniques on growth, productivity, quality and economics of barley (*Hordeum vulgare* L.). *Internat. J. agric. Sci.*, **8**(1): 91-97.

Article History **: Received :** *02.03.2011;* **Revised :** *30.08.2011;* **Accepted :** *25.10.2011*

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an important cereal crop after wheat, rice and maize in the world and third important cereal crop after rice and wheat in India. It can be cultivated successfully in areas where less irrigation water is available. It grows successfully in a wider range of climate compared to other cereals. Under Punjab conditions, as grain crop, its potential is less as compared to wheat crop but it performs well under rainfed conditions. Barley is superior to wheat with respect to some minerals and fibre contents. Barley contains water soluble fibre (betaglucons) and oil compound (tocotrinol) which are found to be effective in lowering cholesterol level of blood. The crop is sown with minimum care and management under residual moisture. This crop has potential due its increased industrial demand due to use of malt for preparation of beer. As the increased use of fertilizer has already pose a threat to the human and animal life, the increased use of nitrogenous fertilizers may increase the nitrate content in the underground water which may ultimately affect the animal and human life. Continuous application of nitrogenous fertilizers has depleted soil organic matter, resulting in inherent loss of native soil N, available P, available K and lower production (Srivastava, 1998: Behera *et al.*, 2007).

*** Author for correspondence.**

Integrated nutrient management (INM) techniques have been suggested for the replenishment of chemicals removed by the cop from the soil, maintenance of humus level in the soil, *i.e.* physical texture of the soil, avoidance of weeds, pests and diseases and control of soil acidity and toxicity. The role of soil biota in these principles of INM can not be undermined, since soil microbes contribute in a big way to the soil organic matter dynamics, nutrient use and *in situ* control of pests and diseases. Integration of inorganic and organic sources of nutrients along with bio-fertilizers is found to give higher productivity and more monetary returns in soybean (Bhattacharyya *et al.*, 2008). Integration of inorganic nutrients with farm yard manure is of much importance. Some of the chemical fertilizers can be replaced with farm yard manure. The production potential of barley can be increased with the application of manures in combination with chemical fertilizers. Keeping these points in view, the present study was conducted with main emphasis to optimize integrated nutrient supply in malt barley to increase the productivity on sustainable manner.

MATERIALS AND METHODS

The field experiment was conducted at Punjab Agricultural University, Ludhiana during 2007-08 to 2008-09. The experimental site (30^0 56'N, 75^0 52'E; 247 m ASL), was having deep alluvial loamy sand, low in organic carbon (3.4 g C kg^{-1}) and slightly alkaline (pH 7.5). The region has a sub-tropical climate having cool and dry winters in the crop season (Fig. A).

The experiment was conducted in factorial randomized block design with two varieties (DWRUB 52 and RD 2552) and seven integrated nutrient management treatments [RDF (recommended dose of fertilizer *i.e.* 90 kg N and 30 kg P_2O_5 and 20 kg K_2O/ha), 75 per cent RDF + FYM (5t/ha), 50 per cent RDF + FYM (5t/ha), 75 per cent RDF + FYM (5t/ha) + biofertilizer (*Azotobacter chroococcum*), 50 per cent RDF + FYM (5t/ha) + biofertilizer, 100 per cent through FYM + biofertilizer and absolute control] with three replications.

The barley crop was sown using seed rate of 87.5 kg/ha at line to line spacing of 22.5 cm. The nitrogen dose of 90 kg and phosphorus dose of 30 P_2O_5 per hectare were applied at the time of sowing. A total rainfall of 87.5 mm and 120.2 mm was received in 2007-08 and 2008-09 years, respectively. The crop received two irrigations at 40 and 105 days after sowing. The herbicides (isoproturon @ 1kg/ha + 2,4-D @ 0.62 kg/ha) were applied as tank mix application after first irrigation to control wild oats and other broad leaf weeds. The data on leaf area index and photosynthetically active radiation interception were recorded at 90 days after sowing. The crop was harvested manually at maturity and thrashed with engine operated thrasher. The plant stand and ear density was recorded from one metre row length at two spots per plot. Randomly ten ears were collected from each plot and thrashed manually to calculate grains/ear. During thrashing, 1000-grain sample was collected from each plot to present the 1000-grain weight. The observations on yield attributes, biomass and grain yield were collected at the time of harvest. The following formulas were used to calculate yield response and nutrient use efficiency:

Yield response (%) = [(Treatment yield – Control yield)/ Control yield] × 100

Nutrient use efficiency (kg grain/kg nutrient) = (Treatment yield – Control yield)/ Amount of nutrient applied

Total nitrogen was analysed according to A.O.A.C. (1980). Phosphorus and potassium percentages was determined according to Cottenie *et al.* (1982). For determining micronutrients (DTPA-extractable Fe and Mn content), soil samples were taken at harvesting of rice and micronutrients were determined from 1 : 2 soil-extractant ratio using DTPA-

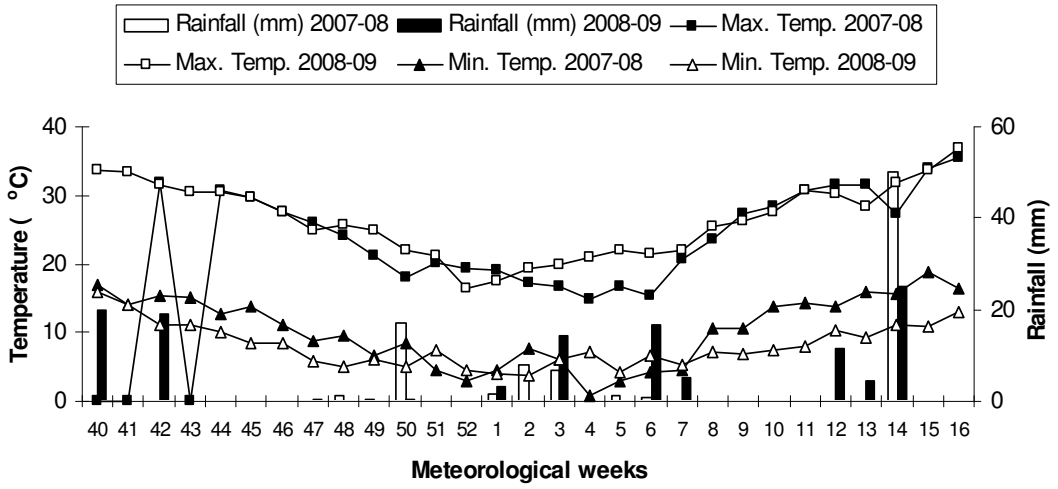

Fig. A : Maximum temperature, minimum temperature and rainfall in *Rabi* seasons of 2007-08 and 2008-09

TEA buffer (0.005 M DTPA + 0.001 M $CaCl_2$ + 0.1 M TEA, pH 7.3) and concentration of these micronutrients was measured on an atomic absorption spectrophotometer (Lindsay and Norvel, 1978). The data were analyzed using standard method of ANOVA.

RESULTS AND DISCUSSION

The results of the present study alongwith relevant discussion have been presented as under:

Effect of varieties:

The data collected on leaf area index, photosynthetically active radiation interception was recorded at 90 days after sowing, total tillers and ear heads per square metre were not significantly influenced by any of the variety in both years (Table 1). It might be due to similar growth behaviour of these two varieties. The grains per ear were significantly higher in RD 2552 than DWRUB 52. It might be due to the reason that RD 2552 is six rowed variety whereas DWRUB 52 is two rowed variety. The data collected on 1000-grain weight was found to be highest in the DWRUB 52 variety which was significantly higher than RD 2552 and it might be due to bolder grains of variety DWRUB 52. The biological yield and grain yield in both years and harvest index in 2007-08 were not significantly influenced by any of the variety (Table 2). However harvest index in 2008-09 was significantly higher in case of DWRUB 52 than RD 2552. Although the grain yield was non-significant but DWRUB 52 recorded slightly higher grain yield than RD 2552. However, Chakrawarty and Kushwaha (2007) reported highest grain yield of variety RD 2552 among three varieties *i.e.* RD 2552, K 560 and DL 88. On the other hands the protein, phosphorus and potassium content of grain were not influenced by any of the variety (Table 2). The micronutrient content of soil after two years of experimentation was not influenced by the varieties of the barley (Table 3).

Nutrient management techniques:

The highest leaf are index (LAI) was recorded in 75 per cent RDF +FYM which was statistically at par with RDF, 50 per cent RDF +FYM and 75 per cent RDF +FYM + biofertilizer but significantly higher than DWRUB 52 + absolute control and rest of the treatments in 2007-08 (Table 1). But in 2008-09, LAI was highest in 75 per cent RDF +FYM + biofertilizer which was statistically at par with 75 per cent RDF + FYM only. It might be due to better soil nutrition in these treatments for the development of LAI. The photosynthetically active radiation interception is important which helps to convert solar radiation into dry biomass. The highest PAR interception was recorded in 75 per cent RDF + FYM in 2007-08 and in 75 per cent RDF +FYM + biofertilizer in second year which were statistically at par with RDF and 75 per cent RDF + FYM + biofertilizer in 2007-08 and with 75 per cent RDF + FYM treatment. Total

Table 1 : Effect of varieties and nutrient management treatments on leaf area index (LAI), photosynthetically active radiation interception PARI (%) and yield attributes of barley

Treatments	LAI (At 90 DAS)		PARI (%) (At 90 DAS)		Total tillers (No./m²)		Ear heads (No./m²)		Grains/ear		1000 grain weight (g)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Varieties												
DWRUB 52	3.55	3.87	78.2	82.6	456	458	431	441	28.5	28.5	41.9	50.3
RD 2552	3.58	38.2	79.6	83.3	455	403	419	403	41.2	49.1	38.0	41.1
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	4.1	2.3	2.1	2.0
Nutrient management												
RDF	3.15	4.08	82.8	86.2	458	418	435	411	39.0	39.6	40.1	41.9
75% RDF + FYM + BF (5 t/ha)	3.92	4.28	86.1	90.1	461	463	438	425	41.3	43.8	40.2	46.0
50% RDF + FYM (5 t/ha)	3.69	3.95	81.5	87.5	459	471	431	421	41.2	36.9	39.1	46.1
75% RDF + FYM (5 t/ha) + BF	4.11	4.35	82.1	92.0	463	411	443	439	39.2	39.5	40.6	46.6
Biofertilizer												
50% RDF + FYM (5 t/ha) + BF	3.79	3.95	81.1	83.5	460	455	432	423	41.1	40.8	39.5	45.1
Biofertilizer												
100% Azotobacter + PSB	3.60	3.87	79.5	81.2	451	412	430	405	36.9	37.8	40.3	41.3
Biofertilizer												
Absolute control	2.80	3.01	61.9	63.6	430	368	365	333	31.1	33.3	39.3	41.9
CD (P=0.05)	0.21	0.22	3.8	3.5	12.1	23.0	10	28.2	NS	3.5	NS	1.3
NS = Non significant												

tillers/square metre is an important character which determines the effectiveness of any of the treatment. The highest tillers/ square metre in 2007-08 were recorded in 75 per cent RDF + FYM which was significantly higher than absolute control but statistically at par with rest of the treatments. In 2008-09, the highest tillers were recorded in 75 per cent RDF +FYM + biofertilizer which was statistically at par with 75 per cent RDF +FYM, 50 per cent RDF + FYM and 50 per cent RDF + FYM + biofertilizer but significantly higher than rest of the treatments. The data recorded on ear heads/square metre were highest in 75 per cent RDF + FYM + biofertilizer in both the years of study which was significantly higher than absolute control in 2007-08 and in 2008-09 it was significantly higher than absolute control and 100 per cent NPK through FYM + biofertilizer treatment. Sepat *et al.* (2010) also reported enhanced early vegetative growth in terms of higher leaf area index, dry matter accumulation and vigorous root system resulted in more number of spikes which consequently increased the number of spike bearing tillers significantly in wheat. The grains/ear in 2007-08 were not significantly influenced by any of the treatment but in 2008-09 it was highest in 75 per cent RDF + FYM which was statistically at par with 50 per cent RDF + FYM + biofertilizer but significantly higher than all the rest of treatments. The data recorded on 1000-grain weight revealed that highest value was recorded in 100 per cent NPK through FYM + biofertilizer it was non-significant in 2007-08 but statistically at par with 75 per cent RDF + FYM, 50 per cent RDF + FYM and 75 per cent RDF + FYM + biofertilizer treatments but significantly higher than rest of the treatments. It might be due to better partitioning of the photosynthates to the developing grains which ultimately increased the 1000-grain weight.

The biological yield was highest in 2007-08 in 75 per cent RDF + FYM which was statistically at par with RDF, 75 per cent RDF + FYM + biofertilizer and 50 per cent RDF + FYM + biofertilizer treatments but significantly higher than rest of the treatments (Table 2). In 2008-09, the highest biological yield was recorded in 75 per cent RDF + FYM + biofertilizer which was statistically at par with 75 per cent RDF +FYM but significantly higher than rest of the treatments. All the treatments recorded significantly higher grain yield than their absolute control (Table 2). The highest grain yield was recorded in 75 per cent RDF + FYM in 2007-08 and in 75 per cent RDF +FYM+ biofertilizer in 2008-09 which was statistically at par with RDF and 75 per cent RDF + FYM + biofertilizer treatments in 2007-08 and in 75 per cent RDF +FYM treatment but significantly higher than rest of the treatments. The higher grain yield might be due better biological yield and yield attributes in these treatments (Table 1). Sepat *et al.* (2010) recorded that 90-19.8-37.5 kg N-P-K (75 % RDF) + 5 tonne FYM + 25 kg $ZnSO_4$/ha along with biofertilizers *viz.*, *Azotobacter chroococcum*, PSB and mixed culture of VAM produced higher grain yield than recommended dose of

Table 2 : Effect of varieties and nutrient management treatments on biological yield, grain yield and quality of barley

Treatments	Biological yield (q/ha)		Grain yield (q/ha)		Harvest index (%)		Chlorophyll (%)		N (%)		K (%)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Varieties												
DWRUB 52	117.9	128.11	48.1	58.73	40.8	39.5	10.1	9.6	0.224	0.222	0.392	0.361
RD 2552	112.9	128.11	45.1	55.18	40.2	37.1	9.9	9.5	0.215	0.201	0.365	0.327
C.D. (P=0.05)	NS	NS	NS	NS	NS	2.1	NS	NS	NS	NS	NS	NS
Nutrient management												
RDF	120.1	124.35	49.1	59.12	39.1	47.5	10.5	10.1	0.224	0.222	0.385	0.355
75% RDF + FYM @ 5 t/ha	124.8	132.98	51.1	62.00	41.2	46.5	10.6	10.3	0.228	0.221	0.385	0.358
50% RDF + FYM @ 5 t/ha	111.2	130.79	48.3	57.97	43.1	38.1	10.2	9.8	0.221	0.218	0.380	0.352
75% RDF + FYM @ 5 t/ha + biofertilizer	119.1	136.45	49.0	63.09	41.1	39.0	10.1	10.1	0.221	0.225	0.388	0.361
50% RDF + FYM @ 5 t/ha + biofertilizer	119.1	130.33	45.1	51.28	38.2	40.8	10.2	9.1	0.221	0.211	0.381	0.351
100% through FYM + biofertilizer	115.5	121.11	41.2	55.61	40.9	38.5	10.1	9.6	0.219	0.215	0.378	0.345
Absolute control	92.1	108.82	36.1	43.59	39.6	33.8	9.5	8.5	0.195	0.175	0.351	0.335
C.D. (P=0.05)	9.1	9.8	6.3	7.0	0.5	0.6	0.7	0.3	0.006	0.008	0.012	0.017
NS Non significant												

Table 3 : Effect of different treatments on micronutrient content (ppm) in soil

Treatments	Micro-nutrient content (ppm) in soil			
	Fe	Zn	Cu	Mn
Varieties				
DWRUB 52	6.60	0.75	0.30	5.03
RD 2552	6.51	0.76	0.31	5.09
C.D. (P=0.05)	NS	NS	NS	NS
Nutrient management				
RDF	5.94	0.67	0.35	4.10
75% RDF + FYM (5t/ha)	7.07	0.80	0.49	4.58
50% RDF + FYM (5t/ha)	6.53	0.72	0.38	4.26
75% RDF +FYM (5t/ha) +biofertilizer	6.94	0.83	0.50	4.74
50% RDF + FYM (5t/ha) + biofertilizer	6.70	0.76	0.40	4.56
100% through FYM + biofertilizer	7.70	0.88	0.54	7.28
Absolute control	5.01	0.6	0.28	3.88
C.D. (P=0.05)	0.45	0.11	0.11	0.25

NS=Non-significant

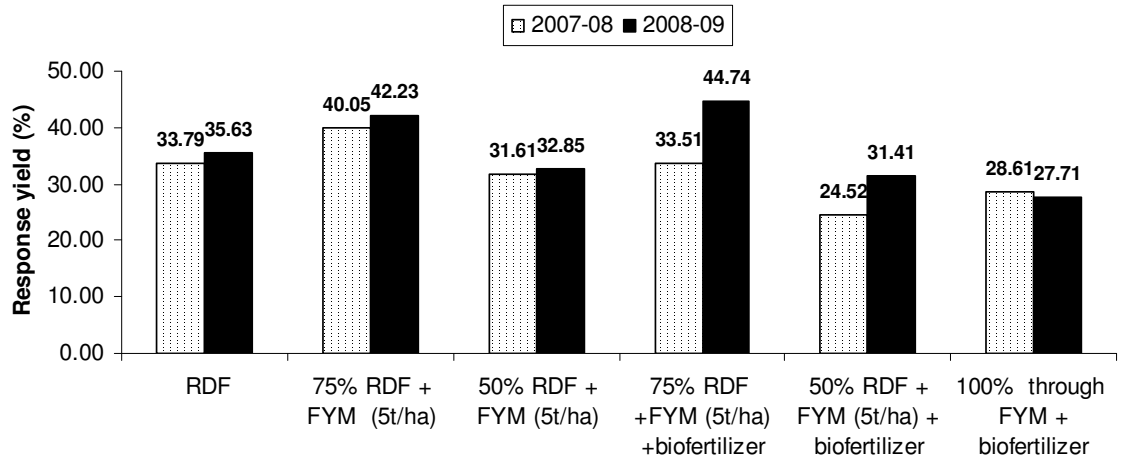

Fig. 1 : Effect of different nutrient treatments on response yield (%) in barley

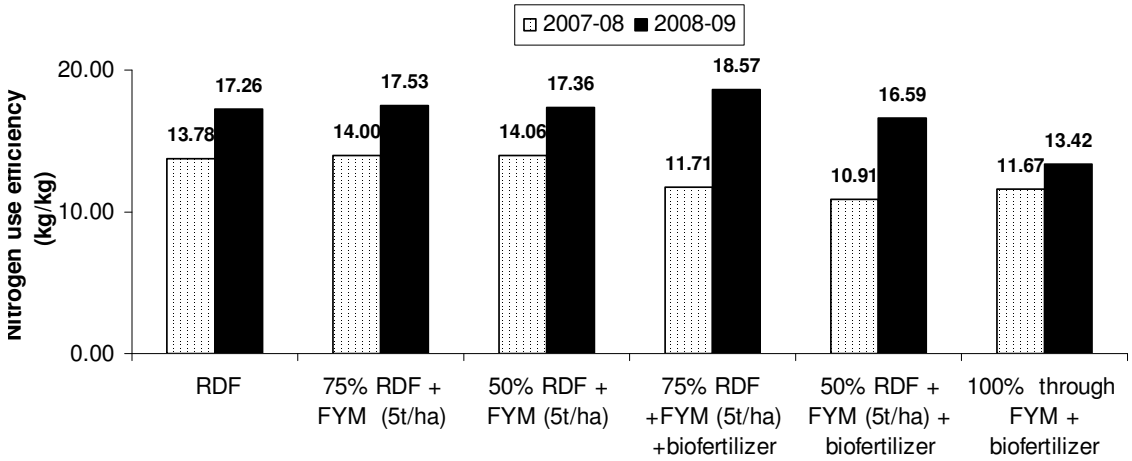

Fig. 2 : Effect of different nutrient treatments on nitrogen use efficiency in barley

nutrient in wheat. The highest harvest index was recorded in 75 per cent RDF + FYM + biofertilizer in 2007-08 and in 2008-09 and it was highest in 50 per cent RDF + FYM treatment. Singh *et al.* (2011) reported that combined application of organic manures and inorganic fertilizers increased the dry matter accumulation, number of grains/spike, grain yield, straw yield and NPK uptake by wheat crop compare to treatment where NPK applied through urea, single superphosphate and murate of potash. Shivakumar and Ahlawat (2008) recorded that the combined application of 5t/ha each of crop residue, FYM and 5 kg/ha zinc along with 100 per cent RDF to soybean was helpful in realizing higher productivity and net returns of soybean–wheat cropping system.

All the INM treatments recorded significantly higher crude protein, phosphorus and potassium content than absolute control in both the years under study (Table 2). The treatment of 75 per cent RDF + FYM (5t/ha) + biofertilizer recorded the highest protein content which was significantly higher than absolute control, 50 per cent RDF + FYM (5t/ha) and 50 per cent RDF + FYM (5t/ha) + biofertilizer and 100 per cent through FYM + biofertilizer but statistically at par with 75 per cent RDF + FYM (5t/ha) and RDF treatments. The highest phosphorus content was recorded in 75 per cent RDF + FYM (5t/ha) which was statistically at par with 75 per cent RDF + FYM (5t/ha) + biofertilizer and RDF but significantly higher than absolute control, 50 per cent RDF + FYM (5t/ha), 50 per cent RDF + FYM (5t/ha) + biofertilizer and 100 per cent through FYM + biofertilizer treatments. The potassium content in grain was significantly influenced by the nutrient treatments. The highest potassium content was recorded in 75 per cent RDF + FYM (5t/ha) + biofertilizer which was significantly higher than absolute control in 2007-08 but it was significantly higher than absolute control and 100 per cent through FYM + biofertilizer in 2008-09. The higher crude protein, phosphorus and potassium content in grains possibly might due to higher nutrient content present in the soil. The concentration of crude protein, phosphorus and potassium in 100 per cent through FYM + biofertilizer treatment might be due to less availability of the nutrients.

Yield response was highest in 75 per cent RDF + FYM in 2007-08 which was followed by RDF (Fig. 1). However, in 2008-09, the yield response was highest in 75 per cent RDF +FYM +biofertilizer followed by 75 per cent RDF + FYM. The highest nitrogen use efficiency was recorded in 50 per cent RDF + FYM in 2007-08, however, in 2008-09 it was highest in 75 per cent RDF +FYM + biofertilizer (Fig. 2).

DTPA-extractable Zn, Cu, Fe and Mn in soil:

The highest content of Fe in soil was recorded in 100 per cent through FYM + biofertilizer, iron content was significantly higher than all of the treatments (Table 3). It might be due highest dose of FYM applied in this treatment. Minimum iron content was recorded in absolute control. Among integrated nutrient treatment highest iron content was recorded in 75 per cent RDF + FYM (5t/ha) which was statistically at par with 75 per cent RDF +FYM (5t/ha) +biofertilizer and 50 per cent RDF + FYM (5t/ha) + biofertilizer. The highest Zn content recorded in 100 per cent through FYM + biofertilizer was statistically at par with 75 per cent RDF + FYM (5t/ha) and 75 per cent RDF +FYM (5t/ha) + biofertilizer but significantly higher than RDF, 50 per cent RDF + FYM (5t/ha), 50 per cent RDF + FYM (5t/ha) + biofertilizer and absolute control. The minimum Cu content in soil was recorded in absolute control. The highest copper content in soil in 100 per cent through FYM + biofertilizer was significantly higher than 75 per cent RDF + FYM (5t/ha) and 75 per cent RDF +FYM (5t/ha) +biofertilizer. The highest Mn content recorded in 100 per cent through FYM + biofertilizer was significantly higher than all of the treatments.

Table 4 : Effect of nutrient management chemical composition of barley grains

Treatments	Gross returns (Rs./ha)		Net returns (Rs./ha)		B:C ratio	
	2007-08	2008-09	2007-08	2007-08	2008-09	2007-08
Varieties						
DWRUB 52	31265	38175	18765	31265	38175	18765
RD 2552	29510	35867	17010	29510	35867	17010
C.D. (P=0.05)	NS	2500	NS	NS	2500	NS
Nutrient management						
RDF	31915	38428	19115	25628	2.49	3.00
75% RDF + FYM 5t/ha)	33410	40300	20910	27800	2.67	3.22
50% RDF + FYM (5t/ha)	31395	37642	18595	24842	2.45	2.94
75% RDF +FYM (5t/ha) +biofertilizer	31850	41009	19350	28509	2.55	3.28
50% RDF + FYM (5t/ha) + biofertilizer	29705	37232	17205	24732	2.38	2.98
100% through FYM + biofertilizer	30680	36186	18180	23686	2.45	2.89
Absolute control	23855	28334	14355	18834	2.51	2.98
C.D. (P=0.05)	2018	3108	1881	2931	0.13	0.12

NS=Non-significant