north – west India. *Indian Journal of Fertilizers* **10** (2):52-54.
Annals of Plant and Soil Research 19(1): 110 – 114 (2017)

Effect of integrated nutrient management on barley (*Hordeum vulgare* L.) under north western plain zone of Uttar Pradesh

SANT BAHADUR SINGH

Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra (U.P.) - 283 105

Received: October, 2016; Revised accepted: January, 2017

ABSTRACT

A field experiment was conducted at Agricultural Research Farm, R.B.S. College, Bichpuri (Agra) to study the effect of integrated nutrient management on yield of barley during winter seasons of 2011-12 and 2012-13. Seven treatments were evaluated in randomized block design with three replications. Results revealed that the 100% NPK fertilizers significantly improved the plant height, dry matter accumulation, effective tillers m^{-1}, spike length, spikelets spike $^{-1}$, fertile spikelets spike $^{-1}$, grains spike $^{-1}$, test weight, grain (45.7q ha^{-1}) and straw (71.7q ha^{-1}) yield of barley over control. The maximum values of these parameters were recorded at 75% NPK+5t FYM ha^{-1} + biofertilizer and minimum in control. An additional grain and straw yields of 1.6 and 7.1 q ha^{-1} respectively were realized with 75% NPK + 5 t FYM ha^{-1} over 100% NPK alone. Application of 75% NPK +5 t FYM ha^{-1} + biofertilizer produced grain (49.9 q ha^{-1}) and straw (87.4 q ha^{-1}) of barley which was superior to 100% NPK alone (24.9 and 53.9 q ha^{-1}). The maximum protein yield (543.9 kg ha^{-1}) was obtained with combined use of 75% NPK + 5 t FYM ha^{-1} + biofertilizer. However, the maximum protein contents in grain (11.1%) and straw (3.4%) were recorded with 100% NPK alone. The integrated use of chemical fertilizers and FYM improved the starch content in grain and maximum value (54 %) was recorded with 75% NPK + 5 t FYM ha^{-1} +biofertilizer. The uptake of N, P and K by grain and straw of barley was found to be associated with production of grain and straw resulted by the addition of 75% NPK + 5 t FYM ha^{-1} + biofertilizer. The results indicated that combined use of 100% NPK + 5 t FYM ha^{-1} was the most appropriate nutrient management for higher build up of available N, P and K in post harvest soil.

Key words: Barley, integrated nutrient management, productivity, quality

INTRODUCTION

Barley (*Hordeum vulgare* L) is an important *rabi* cereal crop in India. It has low cost of production and input requirement, so it is preferred by resource poor farmers in the country. The major portion of grain produced is consumed as flour to prepare *Chapaties* or to make "*Sattu*" by roasting and grinding grains. It is also used to prepare malt for manufacturing bear and whisky and other products such as industrial alcohol and vinegar. Malt syrup is utilized in the preparation of candies, breakfast, beverages and medicines. Byproduct of brewing and distilling industry know as 'brewers' and distiller grain is useful as cattle feed. Bold and plump seeded barley varieties are suitable for manufacture of pearl barley and powder products which form the diet of the sick and convalescent people. The crop need less water and is more tolerant to salinity and alkalinity condition than other winter cereals. The crop possessed very high tolerance to drought and salt. The application of FYM in the soil helps in increasing the fertility of the soils as well as physical condition including water holding capacity (Singh *et al.* 2013). FYM which is the major sources of plant nutrients in traditional agriculture, received less emphasis with the advent of high analysis chemical fertilizers.Without detracting from the fact that chemical fertilizer will continue to be main instrument for quicking the pace for agriculture production the recent researches indicated that a judicious combination of organic manures and fertilizers can better maintain the long term soil fertility and sustain high levels of productivity. Therefore, use of both organic manure and chemical fertilizers in appropriate proportion assumes special significance as complementary and supplementary to each other in crop production. The increase in eco-friendly production of barley can be made possible by use of biofertilizer (Azotobactor). Hence, present

Corresponding author E - mail: singhsbrbs28@rediffmail.com

investigation was carried out to study the growth, yield and nutrient uptake behavior of barley to define optimum dose under integrated use of biofertilizer, FYM and fertilizers.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) season of 2011-12 and 2012-13 at Agriculture Research Farm, R.B.S. College Bichpuri (latitude of 27.2^0 East and longitude of 77.9^0 North and at an altitude of 163.4 m above the mean sea level) Agra (Uttar Pradesh). The soil of the experimental field was sandy loam in texture, having pH 8.0, low in organic carbon 3.2 g kg^{-1}, low in available N (162 kg ha^{-1}), low in available P (10 kg ha^{-1}) and medium in K (114 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. The treatments were; T_1: 100% RD of NPK , T_2 : 75% NPK + 5t FYM ha $^{-1}$, T_3: 50% NPK +50 t FYM ha^{-1}, T_4: 75% NPK +5t FYM ha^{-1}+ biofertlizer, T_5: 50% NPK + 5t FYM ha^{-1}+ biofertilizer, T_6: 100% NPK through FYM+ Biofertilizer and T_7: Absolute control. The barley (Variety RD 2552) was sown on November 15, 2011 and November 18, 2012 in both years using 100 kg seeds ha^{-1}. The N, P_2O_5 and K_2O were applied through urea, di-ammonium phosphate and muriate of potash, respectively. Half dose of N as per treatment and full dose of P_2O_5 and K_2O were applied at the time of sowing. Remaining half dose of N was top dressed after first irrigation. Quantity of FYM (N 0.46% P 0.28% and K 0.48%) was mixed in respective plots as per treatments. The other crop management practices were followed as per standard recommendation. The crop was harvested at the physiological maturity. The growth and yield attributing characters (plant height, dry matter accumulation, effective tillers m^{-1}, spike length, spikelets spike $^{-1}$, fertile spikelet spike $^{-1}$, grains $spike^{-1}$ and test weight) and yields were recorded at harvest. Starch content in grain was determined by Fehling solution method. Grain and straw samples were analyzed for N, P and K by adopting standard procedures (Jackson 1973). Nitrogen in grain and straw was determined using Kjeldahl method. Protein content was calculated by multiplying the nitrogen percentage with 6.25. The available N and P status of post harvest soil was estimated as per methods of Subbiah and Asija (1956) and Olsen et *al.* (1954), respectively. The data generated for both years were mean together and analyzed statistically.

RESULTS AND DISCUSSION

Growth and yield attributes

The various treatments had favorable influence on the plant height, dry matter accumulation, effective tillers m^{-1}, spike length, spikelets / spike, fertile spikelets / spike, grains/spike and test weight over control (Table 1). Application of 100% RD NPK showed a significant positive effect on these parameters over control. It might be attributed to the fact that balanced and judicious application of fertilizers ensures synergistic reaction among nutrients and induced translocation of photosynthates from source to sink. Similar results were also reported by Kumawat *et al.* (2006), Ram and Dhaliwal (2012). The integrated use of 5t FYM ha^{-1} along with 50 and 75% RD NPK resulted in an additive effect on these growth and yield attributes over control probably due to beneficial effect of FYM on soil fertility. These yields attributes further increased by integrated use of FYM along with biofertilizer and NPK fertilizers.

Table 1: Growth and yield attributes at harvest as influenced by different treatments (mean of 2 years)

Treatments	Plant height (cm)	Dry matter accumulation (g)	Effective tillers m^{-1}	Spike length (cm)	Spike lets $spike^{-1}$	Fertile spike lets $spike^{-1}$	Grains $spike^{-1}$	Test weight (g)
100% RD of NPK	65.7	84.2	65.8	7.1	40.9	34.3	24.4	46.7
75% NPK + 5t FYM ha^{-1}	67.0	84.5	69.4	7.2	41.5	35.0	25.6	47.0
50% NPK + 5t FYM ha^{-1}	59.6	77.3	64.5	6.3	20.8	18.7	23.6	46.4
75% NPK + 5t FYM ha^{-1} + Bio.	73.4	88.3	69.5	7.3	42.0	35.2	27.2	47.0
50% NPK + 5t FYM ha^{-1} + Bio.	63.9	83.7	65.3	6.4	21.3	19.6	24.4	46.6
100% NPK as FYM ha^{-1} + Bio.	58.3	79.2	58.6	6.2	18.9	17.7	22.3	46.0
Absolute Control	57.5	72.7	50.5	5.3	18.4	16.6	17.8	43.6
SEm $\pm$	0.98	2.83	0.99	0.23	0.93	0.67	0.92	0.19
C.D.(P=0.05)	2.80	8.25	2.75	0.64	2.58	1.87	2.70	0.55

However, the maximum values of these growth and yield attributes were recorded under combined use of 75% NPK + 5t FYM ha^{-1} + biofertilizer (T_4) indicating that supplementing the inorganic fertilizers with FYM and biofertilizer improved the general soil environment which helped to improve the barley growth and yield attributes. Hasim *et al.* (2015) also reported similar results. Application of 100% NPK through FYM + biofertilizer also improved these growth and yield attributes significantly over control but proved inferior to other treatments.

Yield

The grain and straw yields of barley were affected significantly by various treatments (Table 2) over control. Application of 100% NPK alone increased the grain and straw yield by 83.5 and 33% over control, respectively. It is because of the appropriate dose of NPK could make better combination for completion of prominent processes like chlorophyll synthesis, enzyme activation for biochemical reaction with in plant tissue where in the plant get good opportunity for nutrient uptake which results in higher growth and development of plant as well as yield. Similar results were reported by Jat *et al.* (2012), Singh *et al.* (2013) and Hasim *et al.* (2015). Application of 50% NPK + 5t FYM ha^{-1} resulted in 64.6 and 11.5% increase in grain and straw yield of barley over control, respectively. The corresponding increases in yields due to 75% NPK + 5 t ha^{-1} over control were 89.9 and 46.2 Percent. This higher productivity may be attributed to a sustained availability of essential nutrients to plants. Combined use of FYM and biofertilizer with chemical fertilizers gave the higher yields and proved significantly superior to most of the treatments. The maximum grain (49.9 q ha^{-1}) and straw (87.4 q ha^{-1} yields of barely were recorded with 75% NPK + 5 t FYM ha^{-1}+ biofertilizers treatment. The beneficial effect of FYM and biofertilizer may be due to their contribution in supplying additional plant nutrients, improvement of soil physical conditions and biological process in soil. These results are in conformity with the finding of Jat *et al.* (2012), Chaudhary *et al.* (2013). Application of 100% NPK through FYM + biofertilizer also improved the grain and straw yield of barley over control. But this treatment proved inferior to integrated use of chemical fertilizers, FYM and biofertilizer. Thus, the results indicate that for the same targeted yield is obtained with full inorganic fertilizer (NPK), about 25% of the NPK requirement can be supplemented though 5t FYM ha^{-1}+ biofertilizer. The harvest index ranged from 33.2 to 41.7 per cent and maximum value of harvest index was recorded under T_6 (100% NPK through FYM + biofertilizers) treatment (Devi *et al.* 2011).

Table 2: Yield and quality of barley as influenced by various treatments (mean of two years)

Treatment	Yield q ha^{-1}		Harvest index (%)	Starch in grain (%)	Protein (%)		Protein yield (kg ha^{-1})
	Grain	Straw			Grain	Straw	
100% RD of NPK	45.7	71.7	40.8	52.6	11.1	3.4	507.3
75% NPK + 5t FYM ha^{-1}	47.3	78.8	39.4	53.2	10.8	3.2	510.8
50% NPK + 5t FYM ha^{-1}	41.0	67.7	39.7	51.0	10.6	3.1	434.6
75% NPK + 5t FYM ha^{-1} + Bio.	49.9	87.4	38.1	54.0	10.9	3.3	543.9
50% NPK + 5t FYM ha^{-1} + Bio.	44.9	69.8	41.0	52.0	10.7	3.2	480.4
100% NPK as FYM ha^{-1} + Bio.	41.7	63.2	41.7	51.5	10.6	3.2	442.0
Absolute Control	24.9	53.9	33.2	52.0	10.1	2.8	251.5
SEm $\pm$	1.11	2.70	0.60	0.14	0.12	0.04	5.3
C.D.(P=0.05)	3.26	7.86	1.74	0.41	0.35	0.12	15.7

Quality

The lowest values of content and yield of protein were recorded in control (Table 2) which may be attributed to low nitrogen status of soil. The protein content in barley grain increased from 10.1% at control to 11.1% with 100% NPK. The corresponding increase in protein content in barley straw was from 2.8 to 3.4 per cent. The protein synthesis is closely associated with the supply of nitrogen. Nitrogen is a constituent of amino acids and proteins. Increased supply of nitrogen, therefore, resulted in grater protein content in barley grain and straw. The higher content and yield of protein in barley crop were noted under 50 and 75% NPK along with 5t FYM ha^{-1} over control. The magnitude of increase was higher with 75% NPK + 5 t FYM ha^{-1} as

compared to 50% NPK + 5t FYM ha^{-1}. FYM itself contains N and upon its decomposition produces many organic acids which in turn make the insoluble N soluble and thus increase nitrogen availability. Similar were the results of Ram and Dhaliwal (2012). The content and yield of protein were further increased when NPK levels were applied along with FYM and biorertilizer. The higher protein yield (543.9 kg ha^{-1}) was recorded with 75% NPK + 5 t FYM ha^{-1} + Biofertilizer (Singh *et al.* 2013). Application of 100% NPK through FYM + biofertilizer also improved the content and yield of protein in barley over control. But this treatment proved inferior to 75% NPK + 5 t FYM ha^{-1} + biofertilizer in respect of content and yield of protein in barley. The starch content in barley grain ranged from 52.0% at control to 54.0% with 75% NPK + 5 t FYM ha^{-1} + biofertilizer. The integrated use of chemical fertilizers, manure and biofertilizer proved superior to other treatments in respect of starch content in barley grain. The lowest value of starch (52.0%) content was recorded under control treatment.

Uptake of nutrients

The values of nutrients uptake followed, the same pattern of yield obtained in different treatments. The N uptake by grain and straw of barley significantly increased with 100% NPK over control. A further increase in nitrogen uptake by barley grain and straw was recorded with NPK levels along with 5 t FYM ha^{-1} which may be attributed to greater production of grain and straw. The highest uptake of N by grain (87.3 kg ha^{-1}) and straw (46.3 kg ha^{-1}) was recorded with 100% NPK + 5 t FYM ha^{-1} + biofertilizer treatment (T_4). Similar results were reported by Chakrawarty and Kushwah (2009). The uptake of P by barley crop was significantly higher with 100% NPK over control. This increase may be attributed to better growth and yield of barley. The relatively higher uptake of P by barley grain and straw was recorded with 75% NPK + 5 t FYM ha^{-1} which differed significantly with 50% NPK +5 t FYM ha^{-1}. Higher phosphorus uptake could be attributed to conversion of native phosphorus in to readily available form by organic acids released during the decomposition of FYM and consequent improvement in the available P in soil and better biochemical actively in the crop plants. The maximum P uptake was recorded with 75% NPK + 5 t FYM ha^{-1} + biofertilizer which may be attributed to beneficial effect of FYM and biofertilizer (Devi *et al.* 2011).The uptake of potassium increased significantly with 100% NPK over control which may be due to higher availability of the nutrients in question as compared to control. The higher uptake of K by the barley crop was recorded with NPK levels (50and 75% RDF) along with 5t FYM ha^{-1} indicating the beneficial effect of integrated use of FYM and chemical fertilizers. The combined use of 75% NPK +5 t FYM ha^{-1} resulted in higher uptake of K than that of 50% NPK +5 t FYM ha^{-1}. The combined use of NPK + FYM +biofertilizer proved beneficial as it increased the K uptake by barley grain and straw significantly over control and most of the treatments. This might be due to continuous release of nutrients from soil enriched with FYM and biofertilizer. These results are in conformity with the findings of Singh *et al.* (2013).

Table 3: Nutrient uptake in barley and status of available nutrients in post harvest soil as influenced by different treatments (mean of 2 years)

Treatments	Nutrient uptake (kg ha^{-1})						Avail.nutrients (kg ha^{-1})		
	Nitrogen		Phosphorus		Potassium		N	P	K
	Grain	Straw	Grain	Straw	Grain	Straw			
100% RD of NPK	81.3	38.7	8.7	8.6	23.8	136.2	150	10.6	120
75% NPK + 5t FYM ha^{-1}	81.4	40.2	8.0	7.9	23.7	147.4	160	12.3	135
50% NPK + 5t FYM ha^{-1}	69.3	33.9	6.2	6.1	19.7	125.2	142	9.8	112
75% NPK + 5t FYM ha^{-1} + Bio.	87.3	46.3	8.0	9.6	25.4	165.2	168	12.5	137
50% NPK + 5t FYM ha^{-1} + Bio.	76.8	35.6	6.7	7.0	22.0	129.8	150	10.2	118
100% NPK as FYM ha^{-1} + Bio.	70.9	32.2	6.3	6.3	20.4	118.2	155	10.4	128
Absolute Control	40.1	24.3	3.7	3.8	11.2	97.0	130	8.8	95
SEm±	2.8	0.8	0.27	0.3	0.8	3.2	1.9	0.4	1.6
CD (P=0.05)	8.0	2.4	0.80	1.0	2.4	9.2	5.6	1.2	4.5

Soil fertility

Pooled mean data for available N, P and K in post harvest soil as affected by nutrient management practices are given in Table 3. Available N content varied from 130 to 168 kg ha^{-1} as compared to initial value of 162 kg ha^{-1}. The corresponding variations in the status of available P and K were from 8.8 to 12.5 kg ha^{-1} and from 95 to 137 kg ha^{-1}. The combined application of chemical fertilizers and FYM was found beneficial in improving soil fertility status as compared to sole application of chemical fertilizers. The status of N and P was further improved when the chemical fertilizers were applied along with FYM and biofertilizer. The maximum values of available N (168 kg ha^{-1}), P (12.5kg ha^{-1}) and K (137 kg ha^{-1}) were recorded under 75% NPK + 5t FYM + biofertilizer treatment (T_4). Similar results were reported by Chaudhary *et al.* (2013) and Singh *et al.* (2013). Based on the study, it is concluded that to get maximum productivity and quality from barley in alluvial soil, the crop should be managed with combined use of 75% NPK + 5 t FYM ha^{-1} + biofertilizer in Agra region of western Uttar Pradesh.

REFERENCES

Chakrawarty, V.K. and Kushwaha, K.P. (2009) Performance of barley (*Hordeum vulgare* L.) varieties under sowing dates and nutrient levels in Bundelkhand. *Progressive Research* **2** (2): 163 -164.

Chaudhary, Shripal; Yadav, L.R. Yadav, S.S.; Sharma, O.P. and Keshwa, G.L. (2013) Integrated use of fertilizers and manures with foliar application of iron in barley (*Hordeum vulgare* L.). *Indian Journal of Agronomy* **58** (3): 363 – 367.

Devi, K.N., Singh, M.S., Singh, N.G. and Athokpam, H.S. (2011) Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.) *Journal of Crop and Weed* **7** (2): 23-27

Hasim, M., Dhar, S., Vyas, A.K., Pramesh, V. and Kumar, B. (2015) Integrated nutrient management in maize (*Zea mays*) – wheat (*Triticum aestivum* L.) cropping system. *Indian Journal of Agronomy* **60** (3) :352-359

Jackson, M.L. (1973) *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 111-204.

Jat, N.K., Kumar, A., Meena, S.R., Rana, D.S., Meena, B.P. and Rana, K.S. (2012) Influence of integrated nutrient management on the productivity, quality and soil health of maize (*Zea mays*) – wheat (*Triticum aestivum* L.) cropping system. *Indian Journal of Agronomy* **57**(4):327 -332.

Kumawat, P.D.: Jat, N.L. and Yadav, S.S. (2006) Effect of organic manure and nitrogen fertilization on growth, yield and economics of barley (*Hordeum vulgare* L.). *Indian Journal of Agricultural Sciences* **76** (4): 226 – 229.

Olsen, S.R., Cole, C.V. Watanabe, F.S. and Dean, L.A. (1954) Estimation of available phosphorus in soil by extraction with sodium bicarbonate, Circular No. 939 United States Department of Agriculture, p 1-19.

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.). I*nternational Journal of Agricultural Sciences* **8** (1); 91-97

Singh, V; Singh, S.P., Singh, S. and Shivay, Y.S. (2013) Growth, yield and nutrient uptake by wheat (*Triticum aestivum* L.) as affected by biofertilizers, FYM and nitrogen. *Indian Journal of Agricultural Sciences* **83** (3) 331 – 334.

Subbiah, B.V. and Asija, G.L. (1956) A Rapid procedure for the estimation of available nitrogen in soils. *Current Science* **25**: 259 - 60.