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Soil Test Crop Response Based Fertilizer Requirement for Barley

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Abstract Soil test crop response correlation experiment was conducted on barley at Pantnagar (29°N latitude, 79°29´ E longitude) in *Tarai* region of Uttarakhand during *rabi* of 2010-11. Fertilizer adjustment equations were developed for optimum fertilizer requirement to attain different yield targets. The nutrient requirement (kg q^{-1}) of N, P and K for producing one quintal of barley grain yield was found 2.57, 0.47 and 2.32 kg respectively. The percent contribution of N, P and K from soil was 32.96, 77.42 and 34.61, from FYM 15.4, 8.1 and 19.7, from fertilizers 86.13, 34.45 and 138.6 and from fertilizer with FYM was 88.23, 40.3 and 152.5 respectively. Fertilizer adjustment equations and ready reckoner for fertilizer requirement at varying soil test values for attaining yield target of 35 q ha^{-1} of barley yield was calibrated based on the targeted yield concept.

Keywords Barley, Fertilizer requirement, Target yield, Soil test, Crop response.

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Introduction

Production of barley in India during 2014-2015 was 1.83 million metric tonnes [1]. In India rainfed agro-ecologies contribute 60% of the net sown area and about 50% of cereals are cultivated under un-irrigated conditions [2]. It is an important *rabi* crop especially for the low input and rainfed conditions of Uttar Pradesh, Uttrakhand, Rajasthan, Madhya Pradesh, Bihar and Haryana states. Barley is also an important grain crop of rainfed areas of Uttarakhand and cultivated in about 24 thousand hectares area producing about 26 thousand tonnes which shares 1% of total area and 2% total production of India [3]. The crop yields stagnation as well as no further increment in crop yield is emerging challenge for researchers.Fertilizer is one of the costlies inputs in agriculture and the use of right amount of fertilizer is a fundamental for farm profitability and environmental protection [4]. To enhance profitability under different soil-climate conditions, it is necessary to have information on optimum fertilizer requirements for crops. Therefore soil test based fertilizer recommendation for targeted yield may play an important role in this direction. This approach describes how much fertilizer nutrient is to apply for a profitable response [5]. Besides, this approach also provides an idea of the

Table 1. Basic data for calculating fertilizer requirement for targeted yield of barley.

Particulars	N	P	K
Nutrient requirement to produce one quintal of barley grain NR (kg q^{-1})	2.57	0.47	2.32
Percent contribution from soil as its available nutrients C_s (%)*	32.96	77.42	34.61
Percent contribution from applied fertilizer nutrient with FYM C_f (%)	88.23	40.30	152.5
Percent contribution from applied fertilizer nutrient without FYM C_t (%)	86.13	34.45	138.6
Percent contribution from applied FYM nutrients C_{fym} (%)	15.4	8.1	19.7

Table 2. Fertilizer requirement equation for barley. FN, FP and FK denotes fertilizer nitrogen, phosforus and potassium requirement (kg ha^{-1}), T=Yield target (q ha^{-1}); SN, SP and SK=Soil test values for available N, P, K respectively, ON, OP and OK=Quantities of N, P and K supplied through FYM in kg ha^{-1}.

Ferti-lizer require-ment (kg ha^{-1})	Relationship NPK + FYM	NPK alone	Soil test method used
FN	2.91T-0.37 SN-0.17ON	2.98T-0.38SN	Alk$KMnO_4$-N
FP	1.16T-1.92SP-0.20OP	1.36T-2.25SP	Olsen's-P
FK	1.52T-0.22SK-0.12OK	1.67T-24SK	NH_4OAc-K

fertilizer needs based on yield and nutritional requirement of crop, percent contribution of soil available nutrient and that of the applied fertilizers [6]. Keeping this in view, present investigation was carried out to calculate fertilizer requirement based on soil test values for attaining yield target of barley in Mollisol of Pantnagar.

Materials and Methods

A field experiment for soil test crop response correlation studies on barley was conducted at crop research center of GBPUA and T, Pantnagar (29°N latitude, 79°29´E longitude). Prior to this experiment, the whole plot was divided into 3 equal strips and fertility gradient was created artificially through differential application of fertilizers and by growing sorghum as an exhaust crop during *kharif* of 2010, to minimize the interference of other soil and management factors affecting crop yield. In the second phase, each strip was further sub divided into 24 (21 treated and 3 control) equal sized plots in the main experiment in *rabi* of 2010 and barley (variety UPB 1008) was grown as test crop. The selected treatment combinations of 4 levels of each N (0, 20, 40, 60 kg ha^{-1}), P_2O_5 (0, 15, 30 and 45 kg ha^{-1}) , K_2O (0, 10, 20 and 30 kg ha^{-1}) and 3 levels of FYM (0. 5 and 10 t ha^{-1}) were tested in these plots. Before fertilizer application, soil samples from individual plot at 0–15 cm depth were collected and analyzed for alkaline $KMnO_4$ nitrogen [7], Olsen's phosphorus [8] and ammonium acetate extractable potassium [9]. Crop was grown by following recommended agronomic practices without irrigation. Plant samples (grain and straw) were collected at physiological maturity stage and were analyzed for total N, P and K contents [10]. Grain and straw yields were recorded at harvesting from each plot and total nutrient uptake was calculated. By using yield, nutrient uptake, soil test value and applied fertilizer doses, the basic data viz. nutrient requirement (kg q^{-1}), soil, fertilizer and organic manure efficiencies (%) was calculated and fertilizer requirements was estimated by following the approach given by Ramamoorthy et al. [6].

Results and Discussion

Results showed that in the experiment available nitrogen ranged from 145 to 239 with a mean of 189 kg ha^{-1}, available phosphorus from 10 to 29.6 with a mean of 16.7 kg ha^{-1} and available potassium between 116 and 247 with a mean of 200 kg ha^{-1}. Grain yield ranged from 19.4 to 46.2 q ha^{-1} with a mean 36.7 q ha^{-1}. It is evident from the above data that a wide variability existed in the soil test values and grain yield which is essential for soil test crop response studies.

The basic data viz. nutrient requirement (kg q^{-1}) for producing one quintal of barley grain yield, per-

Table 3. Nitrogen, phosphorus and potassium requirement for 35 q ha^{-1} targeted yield of barley.

Soil test values (kg ha^{-1})			Fertilizer dose (kg ha^{-1}) under NPK alone			Fertilizer dose (kg ha^{-1}) under NPK+FYM @ 10 t ha^{-1}		
SN	SP	SK	FN	FP	FK	FN	FP	FK
150	10	150	47.3	25.1	22.4	39.8	17.8	15.5
175	15	175	37.8	13.8	16.4	30.6	8.2	10.0
200	20	200	28.3	2.6	10.4	21.3	–	4.5

cent contribution of nutrients from soil, fertilizer and FYM have been calculated (Table 1). These parameters were used to develop fertilizer perception equations under NPK alone and NPK+FYM. The nutrient requirement was 2.57, 0.47 and 2.32 kg ha^{-1} for nitrogen, phosphorus and potassium respectively. The percent contribution was found to be 32.96, 77.42 and 34.61 from soil; 15.4, 8.1 and 19.7 from FYM for nitrogen, phosphorus and potassium respectively. Percent contribution of N, P and K was 86.13, 34.45 and 138.6 from fertilizer alone while 88.23, 40.30 and 152.5 from fertilizer along with farmyard manure respectively. The results indicate that nutrient contributions from the fertilizer source are more than from the soil source which is in close conformity with the results [11, 12].

Using fertilizer requirement equation (Table 2), ready reckoner was prepared for N, P and K fertilizer requirement at varying soil test values for attaining yield targets of 35 q ha^{-1} grain yields of barley (Table 3). The results clearly indicate that as the soil test values for the nutrient increased, the fertilizer requirement for a given yield target decreased. These results accorded with the findings of Chatterjee et al. [13] and Shanthi et al. [14]. Under integrated nutrient management system the required dose of fertilizer is low due to nutrient availability increased by the application of FYM. These results corroborate with the findings of Mahajan et al. [15].

Relationship between grain yield as dependent variable and the soil test values, fertilizer doses, interactions between soil test values and fertilizer doses as independent variables were also established through a multiple regression equation of quadratic model. Y=18.226–0.041 SN + 0.297 SP – 0.0614 SK–0.228 FN–0.0015 FN_2 + 0.847 FP–0.0191 FP_2 + 0.655 FK–0.0117 FK_2 + 0.00239 FNSN–0.0216 FPSP–0.0014 FKSK (R^2=0.735**). From R^2 value, it can be observed that variation upto 73.5% in barley grain yield can be explained with the help of the variation in soil test values, fertilizer doses and their interactions. Use of farm yard manure along with chemical fertilizer resulted in savings of fertilizer nutrients for barley crop. Fertilizer application through target yield approach not only ensures sustainable crop production but also economize the use of costly input i.e. chemical fertilizers.

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