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Soil test crop response studies on Menthol mint (*Mentha arvensis* L.) in Mollisol of North India

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ABSTRACT

*A field experiment as per the technical programme of All India Coordinated Research Project on Soil Test Crop Response Correlation was conducted at N. E. Boroloug Crop Research Centre of the G. B. Pant University of Agriculture & Technology Pantnagar (29° N latitude and 79° 29' E longitude) to study the effect of N, P and K fertilizers along with FYM to develop soil test based fertilizer recommendation equations for efficient and balanced fertilization for Menthol mint grown on Mollisol. The response of Menthol mint (var. Kosi) to selected combinations of three levels of FYM (0, 10 and 20 t ha^{-1}), four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}), four levels of phosphorus (0, 25, 50 and 75 kg P_2O_5 ha^{-1}) and four levels of potassium (0, 25, 50, and 75 kg K_2O ha^{-1}) with simultaneous variations in initial available forms of these nutrients was studied. In the present investigation yield predictability coefficient (R^2 0.932**) with soil, applied nutrients and their interaction was found highly significant. The basic data, i.e. nutrient requirement, soil efficiency, fertilizer efficiency and organic manure efficiency (N, P and K) were obtained with the help of soil test value, yield and plant uptake. Fertilizer adjustment equations were developed from the basic data. On the basis of these equations Ready Reckoner were also prepared at different yield targets and soil test values. Findings from present study can successfully be utilized for the larger parts of* Tarai *region of Uttarakhand as effective guide for efficient and balanced fertilizer recommendation.*

INTRODUCTION

Menthol mint a small Genous of aromatic perennial herbs belonging to family Labiatae (Lamiaceae) is commercially cultivated in subtropical climates. Menthol mint oil is extremely useful in a wide variety of industries, namely food industries, pharmaceutical perfumeries and flavoring industries.

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Menthol mint crop is a heavy feeder of plant nutrients, so it requires high amount of nitrogen, phosphorus, potassium and other nutrients from soil. Chemical fertilizers are the main sources of nutrients for menthol mint crop; however, continuous dependence on chemical fertilizers causes nutritional imbalance and harmful effect on soil physical, chemical and biological properties. Since plant derive nutrient from the both soil and fertilizer, it is necessary to maintain adequate nutrient balance to ensure their economic and

judicious use. Various approaches are used for formulation of fertilizer recommendation. But target yield concept given by Troug [19], which later modified by Ramamoorthy *et al*. [15] have clearly demonstrated that superiority of that approach over others. Soil Test crop Response (STCR) based prescription are gaining popularity due to their superiority over general fertilizer recommendations. Therefore, based on the technical programme of the All India Coordinated Soil Test Crop Response Correlation Project, an experiment was conducted in order to develop soil test based fertilizer recommendation equations for efficient and balanced fertilization in Menthol mint grown on Mollisol of North India.

MATERIAL AND METHODS

The experiment on Menthol mint was conducted at Norman E. Boroloug Crop Research Centre (CRC), G.B. Pant University of Agriculture and Technology, Pantnagar, (29^0 N latitude, 79^0 29' E longitudes) during *Rabi*, 2008-09 on Mollisol as per technical programme of AICRP on Soil Test Crop Response Correlation. The experiment was carried out in two phases' *i.e.* preparatory phase and main phase. In first phase soil fertility gradient was created by dividing experimental field into three strips and applying graded doses of fertilizers in them i.e. no fertilizer in I strip, 100 N, 100 P_2O_5 and 100 K_2O kg ha^{-1} in II strip and 200 N, 200 P_2O_5 and 200 K_2O kg ha^{-1} in III strip. Sorghum (var. - NTJ-2) was taken as exhaust crop for stabilization of the fertility gradient. In second phase i.e. next season test crop Menthol mint (var. Kosi) was grown by dividing each strip in 24 plots having 21 treatments and 3 controlled plots. The crop for preparatory trial was sown in September, 2008 and for main trial Menthol mint was planted in January, 2009. The experimental soil was sandy loam in texture and having low available nitrogen, medium phosphorus and potassium while high organic carbon. Initial soil properties recorded before start of the experiment were pH 7.02, EC 0.27 dSm^{-1} , OC (%) 0.77, available nitrogen 163.07 kg N ha^{-1} , available phosphorus 16.43 kg P ha^{-1} and available potassium 133.27 kg K ha^{-1}.

Response of selected combinations of three levels of FYM (0, 10 and 20 t ha^{-1}), four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}), four levels of phosphorus (0, 25, 50 and 75 kg P_2O_5 ha^{-1}) and four levels of potassium (0, 25, 50, and 75 kg K_2O ha^{-1}) at different fertility levels on menthol mint was studied.

Before fertilizer application, soil samples from individual plot at 0-15 cm depth were collected and analyzed for Organic carbon Walkley and Black [20], available nitrogen alkaline- $KMnO_4$ method Subbiah and Asija, [18], available phosphorus by Olsen *et al.* [14] followed by colour development by ascorbic acid method Murphy and Riley [13] and available potassium by 1 *N* neutral NH_4OAc Hanway and Heidal [10]. Half of nitrogen, total phosphorus, total potash and total dose of FYM were broadcasted as basal and remaining one half of nitrogen was applied as top dressing. The yield data was recorded two times i.e., 80 days and 129 days after planting the crop. Plant samples were collected during harvest and analyzed for nitrogen, phosphorus and potassium contents [11] by Jackson (1973). The uptake of nutrients was calculated using dry herbage yield and nutrient content.

RESULT AND DISCUSSION

A wide variability in soil test value was found in the experimental field before transplanting suckers of test crop Menthol mint. The ranges were 0.77-1.10% for organic carbon, 127.98-190.7 kg ha^{-1} for nitrogen, 12.00-22.50 kg ha^{-1} for available phosphorus and 92-173.76 kg ha^{-1} for available potassium. The fodder yield of sorghum crop among three strips was found between 307.5- 487.5 q ha^{-1} with a mean of 397.5 q ha^{-1} and uptake range for nitrogen was found between 73.52-112.59 kg ha^{-1}, for phosphorus it was 17.05-29.58 kg ha^{-1} and for potassium 137.52-137.52 kg ha^{-1}. It is clear from the above data that sufficient fertility gradient has been created which is a prerequisite of such type of experiment. The ranges and means of Mentha total yield and total nutrient uptake under different strips and different treatments are presented in the Table 1.

Table 1: Ranges and means of Mentha total herbage yield and total nutrient uptake under different strips and treatments

Particular	Strip I	Strip II	Strip III
	Range(mean)	Range(mean)	Range(mean)
Herbage yield (q ha^{-1})	340.00-560.00 (450.00)	345.00-605.00 (475.00)	355.00-620.00 (487.50)
Dry matter yield (q ha^{-1})	177.48-292.32 (234.90)	180.09-315.81 (247.95)	184.80-323.64 (254.22)
Oil yield (L ha^{-1})	165.00- 359.00 (262.00)	182.00 –367.33 (274.66)	181.00 –377.20 (279.1)
Nitrogen uptake (kg ha^{-1})	45.64-94.79 (70.02)	45.97-127.20 (86.58)	43.11-126.04 (84.60)
Phosphorus uptake (kg ha^{-1})	5.68-17.47 (11.57)	5.26-22.46 (13.86)	9.04-26.05 (17.54)
Potassium uptake (kg ha^{-1})	42.00-104.76 (68.38)	49.08-138.32 (93. 70)	57.08-137.65 (97.36)

The above trend observed as per fertility gradient created. It clearly indicates that variation in yield was due to initial fertility gradient and also applied nutrient at different fertility levels. Combined application of FYM and NPK treatments increased the herbage yield. A significant increase in herbage yield of *Mentha arvensis* L. due to application of 80-120 kg N ha^{-1}, 40-60 kg P_2O_5 ha^{-1} and 20-40 kg K_2O ha^{-1} recorded by Gulati and Duhan [9], 80-140 kg N ha^{-1}, 40-60 kg P_2O_5 ha^{-1} and 20- 40 kg K_2O ha^{-1} by Mishra, [12]; 120 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1}, and 40 kg K_2O ha^{-1} Singh *et al.,* [17] in different menthol mint genotypes.

Multiple regression study of soil test values and fertilizer dose with herbage yield of menthol mint

The multiple regression equation of herbage yield of Mentha with soil available nutrients and fertilizer N, P, K variables have been developed by using the quadratic function is presented below:

$$Y = 803.37 - 3.064SN + 0.0086SN^2 - 27.95SP + 0.739SP^2 + 0.00066SK + 0.0026SK^2 - 1.39FN + 0.0055FN^{2*} + 0.170FP - 0.041FP^{2*} + 1.46FK - 0.01FK^2 + 0.0046FNSN + 0.07FPSP - 0.0021FKSK + 0.021FNFP^{*} + 0.0035FNFK + 0.0032FPFK$$

$$R^2 = 0.932^{**}$$

where, Y indicate herbage yield (q ha^{-1}), FN, FP, and FK represent applied fertilizer nitrogen, phosphorus (P_2O_5) and potassium (K_2O) in kg

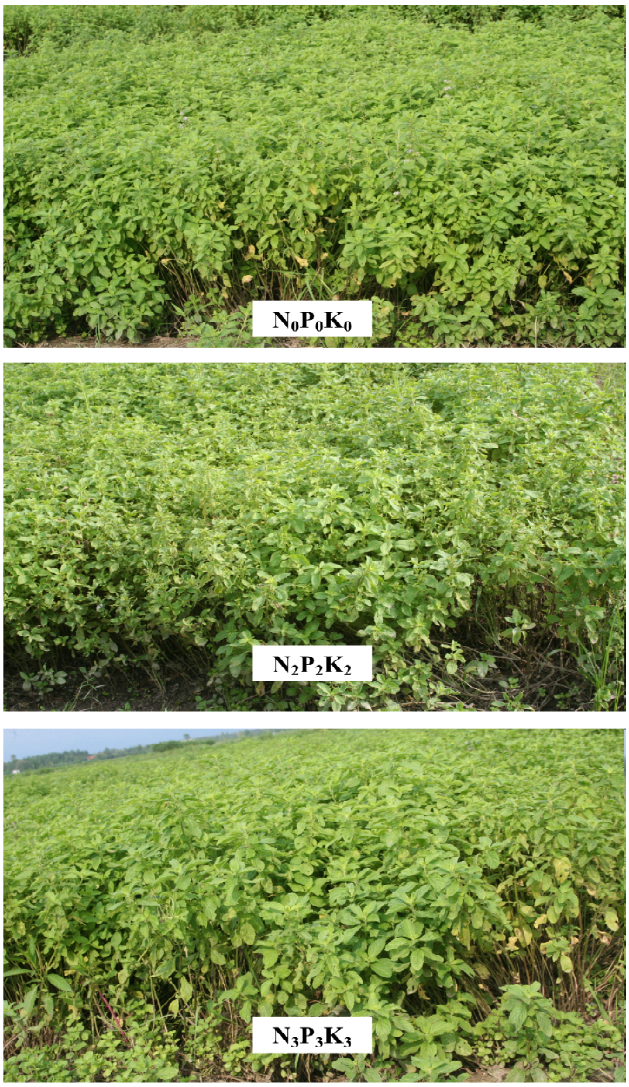

Plate 1: Photographic views of test crop- mint (Mentha sp.)

Table 2: Basic data for targeted yield equations of Menthol mint.

Particular	N	P	K
Nutrient requirement (kg) to produce one quintal of Mentha herbage (NR)	0.31	0.05	0.32
Per cent contribution of soil as its available nutrients (C_s)	22.7	31.4	29.0
Per cent contribution from applied fertilizer nutrient (C_f)	25.0	4.0	28.0
Per cent contribution of nutrient from applied FYM (C_{fym})	35.0	14.0	53.0
Per cent contribution from applied fertilizer nutrient with FYM (C_f)	40.0	7.0	72.0
Fertilizer adjustment equations: FN = 0.775 T-0.567 SN-0.875 FYM-N FP = 0.71T-4.4 SP-2 FYM-P FK = 0.44 T- 0.4 SK – 0.736 FYM-K			

FN, FP and FK: Fertilizer dose (kg ha^{-1}) of respective nutrient. SN, SP and SK: Soil test values (kg ha^{-1}) for Alkaline $KMnO_4$-N Olsen's- P, Amm. Ac.-K; T: Yield target (q ha^{-1}) FYM-N, FYM-P, and FYM-K: Nitrogen, phosphorus and potassium obtained through FYM, respectively.

Table 3: Nitrogen, phosphorus and potassium requirements for targeted herbage yields of Menthol mint.

Soil test values (kg ha^{-1})	Yield targets (q ha^{-1})		
	200	250	300
Alkaline $KMnO_4$-N	**Fertilizer N dose (kg ha^{-1})**		
125	50.8	128.37	205.87
150	36.7	114.2	191.7
175	22.5	100	177.52
Olsen's- P	**Fertilizer P dose (kg ha^{-1})**		
10	26.00	97.00	168.00
15	4.0	75.00	146.00
20	-	53	124.00
Amm. Ac. – K	**Fertilizer K dose (kg ha^{-1})**		
100	20.04	64.04	108.04
125	12.04	54.04	100.04
150	-	44.04	88.04

ha^{-1} respectively, FYM represent farm yard manure in t ha^{-1} and SN, SP and SK represent soil test value for nitrogen phosphorus and potassium in kg ha^{-1}). These relationships suggest that variations in herbage yield of Mentha could be ascribed to changes in soil available and applied fertilizer nutrients with high order of predictability (R^2). The coefficient of yield predictability with soil and applied nutrients was found highly significant and good fit to the data according to STCR norms [1], indicating 93 per cent variation in yield can be predicted by complete set of available soil N, P, & K and applied fertilizer doses of N, P & K and their interaction. The basic data and fertilizer adjustment equations under INM mode for targeted yield of Mentha were evolved using soil test, herbage yield, nutrient uptake and fertilizer dose and presented in table 2.

On the basis of above adjustment equations Ready reckoners for fertilizer recommendation to Menthol mint at different yield targets and soil test values were prepared (Table 3).

The fertilizer dose in table 3 clearly shows that at any yield target fertilizer dose decreases as soil test value increases. However, at any soil test value fertilizer dose increases with increase in yield targets.

CONCLUSION

The practice of fertilizing crops on the basis of yield targets is precise, meaningful, eco-friendly and it needs to be popularized among farmers to obtain higher productivity and profitability. Therefore, soil test based fertilizer recommendation may be a useful tool for balanced fertilization of nutrients. Thus, the present investigation provides the strong basis for judicious and efficient fertilizer recommendation for menthol mint grown in *Tarai* region of Uttarakhand.

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