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Effect of method, time and levels of phosphorus application on yield and quality of tea (*Camellia sinensis*)

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ABSTRACT

A field experiment was carried out at Palampur during 1994–99 on 150-year-old China hybrid tea [*Camellia sinensis* (L.) O. Kuntze] to study the effect of single superphosphate on yield and quality of tea with different methods, times and levels of P application. Phosphorus application at 90 kg P_2O_5/ha with alternate years of application registered significantly highest yield. On the contrary, the highest values for tea quality with regards to total colour and percent brightness were obtained with annual application of fertilizer @ 60 kg P_2O_5/ha with deep placement method. Among the interactions, the highest yield was obtained when phosphorus was applied in alternate years by broadcasting on the soil surface.

Key words : Phosphorus, Tea, Yield, Quality

Phosphorus is one of the major yield-limiting nutrient in most of the Indian soils (Bajaj and Ramamurthy, 1969) in general and acidic soil in particular because of its higher fixation and very low recovery of applied phosphorus. The soils of Kangra district particularly in the vicinity of Dhauladhar ranges are characterized as acidic soils in which nutrient availability especially of phosphorus is a severe problem. This has been attributed to the high content of sesquioxides (Fe and Al) which fix the phosphorus into insoluble phosphate products (Bhattacharya and Singh, 1990). Further, the adsorption of phosphorus by clay and clay minerals also decrease the P availability to plants. Also the phosphate-use efficiency of added P in these soils is fairly low ranging from 10 to 15%. The heavy doses of P are required to satisfy the P-fixing capacity of such soils and to have some P available to plants (Sharma, 1981). Since P is a costly input and its fixation and immobilization leading to poor utilization by individual crops in the soil are some of the principal reasons, which have attracted the attention to formulate more efficient P management of tea in Himachal Pradesh.

MATERIALS AND METHODS

A field experiment was conducted at Tea Experimental Station of the CSK HPKV, Palampur, during 1994–99. Experimental field soil was silty loam having organic carbon 0.97%, available N, P and K 332.4, 29.6 and 185.4, kg/ha respectively, with pH 5.3. The experiment was conducted in factorial randomized block design with 3 replications. Treatments comprising 4 levels of P (0, 30, 60, 90 kg P_2O_5/ha), 2 methods of P application [surface application (M_2) and placement at 10 cm depth in a ring (M_1)] and 3 times of P application [once in a pruning (Y_3), in alternate years (Y_2) and every year (Y_1)] were started. The P applied through single suprphosphate. Basal dose of 90 kg P_2O_5/ha and 40 kg K_2O/ha was applied at the start of season (February). Each experimental plot consisted of 20 bushes established at 1.5 m × 1.5 m spacing. Regular plucking at 7–10 days interval was carried out from April to October. Yearly yield was expressed as kg made-tea/ha (KMTH). During the last year of experimentation, orthodox black tea samples were manufactured in a miniature-manufacturing unit as per instructions contained in *Tea Encyclopaedia* (Wood *et al.*, 1980). The made-tea samples were analysed for total colour and per cent brightness as per method described by Ullah (1986).

RESULTS AND DISCUSSION

Phosphorus application method

The results showed that both the methods of P application, viz. placement at 10 cm depth in a ring (M_1) and broadchasting on soil surface (M_2), were statistically at par and had no significant effect on the yield of tea. However, broadcasting appeared superior to deep placement. It is possible that by broadcasting method, the availability of phosphorus is increased over a larger area due to the feed-

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ing roots compared to the limited availability under the deep placement system. Othieno (1973) also found the increased utilization of applied P in tea soils and was attributed to the concentration of roots near the soil surface.

Phosphorus level

There was a significant and progressive increase in yield with successive increase in P level from 0 to 90 kg P_2O_5/ha. The highest yield of 1,447 kg/ha was at P_{90}. The response of tea crop to phosphorus application may be attributed to the fact that addition of phosphorus improved the root and shoot development by its favourable effect on the cell-division, increased volume and surface area of roots which improved the uptake of not only phosphorus but also other nutrient such as N, K, Ca, Mg and micronutrients (Sinha, 1972; Bajwa and Paul, 1978) which attributed to increase in yield of the crop.

Time of phosphorus application

Time variant or frequency of P application showed significant effect on the yield of tea. The maximum yield (1,379 kg/ha) was observed when the fertilizer was applied once in a pruning cycle (Y_3) over control; however; the yield of tea was statistically at par with application of P fertilizer in alternate years. Mulky and Sharma (1993) also reported that for made-tea (kg/ha) below 3,000, the rate of application of fertilizer should be 80–100 kg P_2O_5/ha applied once in 2 years (alternate years application).

Interactions

Among the interactions, methods × time of P application was found significant and had significant effect on the yield of tea. The highest yield of 1,457 kg/ha was obtained when P was applied in alternate years by broadcasting on the soil surface (M_2Y_2). This might be owing to the fact that tea is a perennial crop and is not sensitive to times and seasons of manurial application similar to response experienced by annual crops, therefore fertilizer applied in a year shows effect in another year. But when P was applied only once in a pruning cycle, deep-placement method also proved effective compared to broadcasting of P on soil surface, resulting yields of 1,437 kg/ha and 1,322 kg/ha respectively. Babilodze (1972) studied the effect of deep placement of phosphorus fertilizers on the development of the tea root-system and on the leaching of nutrients from the soil. He found that deep placement encouraged the formation of fibrous roots, resulted in better moisture availability and reduced root damage during soil cultivation and hence higher yields.

Quality

The methods, levels and time variant significantly influenced the per cent total colour and per cent brightness values. Among the different methods of application, place-

Table 1. Effect of different phosphorus levels, methods and time variant on the yield of made-tea (kg/ha) (cumulative mean of 6 years 1994–99)

Treatment	Levels of P			
	P_{30}	P_{60}	P_{90}	Mean (Methods)
Method of application (M)				
M_1	1,259	1,359	1,409	1,342
M_2	1,327	1,371	1,486	1,394
Time variant (T)				
Y_1	1,257	1,355	1,414	
Y_2	1,289	1,368	1,496	
Y_3	1,334	1,372	1,433	
Mean (levels)	1,293	1,365	1,447	
		Time variant		
Method of application				
	Y_1	Y_2	Y_3	
M_1	1,279	1,311	1,437	
M_2	1,404	1,457	1,322	
Mean (Time variant)	1,342	1,348	1,379	
Control				
kg made tea/ha		1,116		
CD (P=0.05)				
Time variant		79		
Levels		56		
M × T		79		

Details of treatments are given under Materials and Methods