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Effect of different particle sizes of sulphur on yield and nutrient uptake of China hybrid tea [*Camellia sinensis* L. (O).Kuntze]

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Abstract

A field experiment was conducted to evaluate the effect of different particle sizes of sulphur alongwith different sources of sulphur on yield and nutrient uptake of China hybrid tea (*Camellia sinensis*).In all the seasons and resultantly cumulative yield, significant increase in yield has been observed amongst different particle sizes of sulphur followed by gypsum which was statistically at par with medium fine sulphur. Significant response in cumulative nutrient uptake of different nutrients i.e.N,P,K and S and maximum utilization of applied sulphur (2.7%) was observed with medium fine sulphur. A significant correlation existed between nitrogen content and yield during first season(r=0.55), N,P,K and S contents of first season with yield of second season(r=0.80,0.48, 0.46 and 0.44) and N content of first season with yield of third season (r=0.59). The contents of K and S during second season had a positive correlation with yield of second season for K (r=0.50) and third season for S (r=0.65). The yield of third season was significantly correlated with K and S contents during same season (r=0.75 and 0.61 respectively).

Keywords: Sulphur, particle sizes, yield, nutrient uptake, tea.

Introduction

Tea (*Camellia sinensis*), one of the most popular beverage world wide is increasing in popularity because of its positive effect on human health. It is one of the commercial crops of Himachal Pradesh covering about 2315 hectares of area and producing 1500 thousand kgs of tea (Anon. 2000). The yield has been considered to be quite low as compared to other parts of country. However, immense possibilities are there for increasing the productivity through adoption of various scientific agricultural techniques among which sulphur nutrient occupies an important aspect. In tea crop, importance of sulphur is next to nitrogen only. Gypsum and single super phosphate are to be major sources of sulphur, however their increasing costs and opportunity for aerial application has made elemental sulphur (S^o) an alternative. Among different sources of sulphur, use of elemental sulphur (S^o) presents several advantages. It increases availability of P by replacing and releasing the phosphorus from fixation sites of acidic soils (Jaggi, 1992), being a slow release sulphate source, S^o application could reduce leaching and run off losses of sulphate, it could have a prolonged residual effect on the sulphur nutrition and finally being a concentrated source of sulphur, handling and transportation of S^o in for more economical and convenient in hilly region. Biochemical oxidation of S^o converts it in to sulphate form which is only plant available form. The rate at which oxidation occurs is dependent on the particle size of material (Li and Caldwell, 1966) In view of general advantages of the use of S^o fertilizer under Himachal conditions, obviously first step is to determine optimum particle size of S^o which converts into sulphate form at a rate simulating with plant needs so that its losses in different ways are minimised. So, present study is a step in this direction in mountain tea soils of Kangra valley in North-west India.

Material and Methods

The field experiment was conducted in the department of Tea Husbandry and Tehcnology, Himachal Pradesh Agricultural University Palampur, India (Latitude 32° 6' N; longitude 76° 3' E; Altitude 1291 m) under "Mid Hill Temperate Zone" with a moderate hot summer and severe cold winter with an annual rain fall of 2500 mm; mean minimum and maximum temperatures 17.8 °C and 27.6°C, respectively during the growing period (April-October). The soils of this area have been

classified as typic "hapludalfs" with an order"Alfisols" under 7th approximation (Verma, 1979). The soil was acidic (pH 5.4) having silty loam texture and high organic carbon content (1.04%). Available N, P, and K were 312, 22.5 and 203 kg/ ha respectively.

The experiment was laid out in Randomized Block Design (RBD), comprised seven treatments of sulphur through gypsum, agripyrite and elemental sulphur (S^o) of different particle sizes (Fine S <0.25 mm, Medium fine S 0.25 -0.49 mm , Medium coarse S 0.50-0.99mm, Coarse S 1.00-2.00mm) replicated thrice. Each plot consisted of 20 bushes established at 1.5mX 1.5m spacing. N, P_2O_5 and K_2O at the rates of 90, 90 and 45 kg/ha, respectively were applied as basal dose to each plot. Nitrogen was applied through 12:32:16 (NPK) mixture. Additional dose of nitrogen was applied through urea whereas sulphur was given in the form of elemental sulphur (S^o).

Regular plucking was carried out from April to October month of the year at an interval of 7-9 days. Crop yield was expressed in terms of made tea kg/ha (KMTH) as average of 25% recovery of green leaf during entire growing season in this region. A portion of shoots sampled during different seasons were washed thoroughly and dried at 70°C, finally pulverized and digested in di-acid mixture. Nutrient uptake as crop removal was estimated by analyzing tea shoots for N (Jackson, 1973), P by Vanadomolybdo-phosphoric yellow colour method (Jackson, 1973), K by flame photometer (AOAC, 1970) and S was determined by turbidity method using spectrophotometer at 400 nm (Cottenie, 1979).

Results and Discussion

The application of different particle sizes of elemental sulphur and other sources of sulphur exerted a significant effect on three seasons and cumulative yield of made tea during the year (Table 1). In all the seasons and resultantly cumulative yield, application of medium fine sulphur significantly produced the highest yield followed by other sources of sulphur like gypsum which were statistically at par with medium fine sulphur where as rest of treatments were lower in yield and statistically at par with each other excepting fine sulphur. The significant increase in yield with the application of medium fine sulphur might be due to more rapid oxidation of optimum size of sulphur, causing more and easy availability of sulphate to plants which simulated the plant need. Jones and Ruckman (1969) also reported that the application of elemental sulphur was better.

The application of different particle sizes of sulphur and other sources of sulphur influenced the uptake of all other nutrients significantly with the highest values obtained with medium fine sulphur

Table 1. Effect of different particle sizes of sulphur on the seasonal and cumulative yield of made tea (kg/ha)

Treatment	Season I	Season II	Season III	Cumulative
Control	893	484	140	1517
Gypsum	1049	661	192	1902
Agripyrite	1032	582	192	1806
Fine S	906	511	186	1603
Medium Fine S	1117	696	201	2014
Medium Coarse S	1000	572	191	1743
Coarse S	967	551	167	1685
CD(P=0.05)	111	35	30	119

(Table 2). The increased uptake of nutrients can be explained in terms of ideal weather conditions such as cumulative rain fall and relative humidity which were adequate and appropriate during the main flush period. Further the maximum productivity/return with medium fine sulphur could be possibly due to optimum size of sulphur which under went rapid oxidation under prevalent agro climatic conditions, thus making easy availability of nutrients to tea plants whereas contrary to this, with rest of the treatments, availability got reduced with passage of time due to slow release of nutrients which were not simulating plant need. Sharma *et al.* (2000) also reported significant increase in uptake of N, P, K, Ca, Mg and S in tea crop with sulphur application.

There was maximum utilization (2.7%) of applied medium fine sulphur over other particle sizes and sources of sulphur which might be due to exposure of optimum surface area of medium fine sulphur for quicker oxidation to sulphate forms and thus making it easy available to plants. In case of fine sulphur although has larger surface area for quicker oxidation yet does not give higher yield which might be due to higher sulphur concentration prone to leaching and run off losses thus causing low percent utilization.

Correlations between nutrient contents of tea shoots for three seasons with yield were estimated (Table-3). A highly significant correlation with nitrogen content of first season was observed with the three seasons (r=0.55, 0.80, 0.59) of crops which could be possibly due to more availability of N in the plant. Antiya (1984) noticed significant positive correlation between N content of the flush and yield of tea crop. P, K and S contents of this season also

Table 2. Effect of different particle sizes of sulphur on the nutrient uptake (kg/ha) and per cent utilization by tea crop

Treatment	Nutrient Uptake (kg/ha)				% Utilization
	N	P	K	S	
Control	22.6	1.8	1.3	0.9.	-
Gypsum	26.6	2.1	1.7	1.3	1.7
Agripyrite	27.6	2.2	1,7	1.2	1.4
Fine S	24	2.0	1.5	1.1	1.0
Medium Fine S	32.4	2.6	1,9	1.5	2.7
Medium Coarse S	28.5	2.4	1.8	1.4	2.3
Coarse S	24.7	1.9	1.6	1.2	1.1
CD(P=0.05)	1.8	0.2	0.1	0.2	0.4

Table 3. Correlation between nutrients of seasonal tea shoots and seasonal yields

Nutrient Content	Yield (A)			Yield (B)		Yield (C)
	Season I	Season II	Season III	Season II	Season III	Season III
Nitrogen	0.55*	0.80*	0.59*	0.41	0.19	-0.003
Phosphorus	0.12	0.48*	0.43	-0.03	-0.19	0.03
Potassium	0.19	0.46*	0.25	0.50*	0.41	0.75*
Sulphur	0.38	0.44*	0.20	0.42	0.65*	0.61*

A = Nutrient content of Season-I, B = Nutrient content of Season-II, C = Nutrient content of Season-III
* Significant at 5 % Level

contributed for season –II. During second season, the yield was influenced by K(r=0.50) and S(r=0.65). In the third season, the contents of K and S of shoots indicated the significant correlation with yield of that season. Under favourable conditions, nitrogen response commences 3-4 weeks after application. On the other hand delayed effects have been obtained with P, K and S application during second and third season only.

Conclusion

Thus the findings of this investigation conclude that amongst particle sizes of sulphur, medium fine sulphur has given significant highest yield with maximum utilization of applied sulphur.

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