International Journal of Manures and Fertilizers Vol. 3 (3), pp. 495-496, March, 2014. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Short Communication

Yield and quality response of tea plant to fertilizers

Ramah T. Mohammadi, Shahram G. Hatima and Radmehr P. R Arsham

Department of Plant and Crop Science, Faculty of Agriculture, University of Tabriz, East Azarbaijan Province, Iran.

Accepted 28 February, 2013

To improve quality and yield of Iranian tea, this experiment was projected and effects of nitrogen (N), potassium (K), magnesium (Mg) and micronutrients (Zn and Cu) fertilizers was studied on yield and quality of tea. The trial conducted by using factorial split-plot design, with three factors in three replications in RCBD. Nitrogen and potassium fertilizers were both distributed in two levels in a factorial form in main plots and Mg and micronutrients were distributed in subplots with four levels. This experiment included ten times plucking. The total yield of each plot obtained from the sum of ten harvests. The percentage of tannin, water extracts and caffeine percentage was measured for qualitative assessment. Therefore, amount of tea leave nutrients (included N, P, K, Mg, Zn and Cu) were measured. Micronutrient applications, especially treatment of magnesium sulphate + zinc sulphate indicated significant effect ($p<0.01$) on the yield. Urea application had significant effect ($P<0.05$) on tannin and water extract percentage. Interaction of nitrogen, potassium and micronutrient effect was significant on caffeine percentage ($p<0.01$). Nitrogen fertilizer showed significant effect on the percentage of tannin and water extract ($p<5\%$). Micronutrient applications indicated significant effect on percentage of P, Zn and Cu. Combination of N+K + micronutrients was significant on the caffeine percentage ($p<0.01$).

Key words: Tea, fertilizers, micronutrients, yield.

INTRODUCTION

Tea (*Camellia sinensis*) is an important commercial crop in many subtropical and tropical areas of the world. Tea, owing to its favorable effects on human health, currently enjoys a great popularity among other beverages world-wide (Ruan and Härdter, 2001). Tea is a perennial plant, which repeatedly pruned at different intervals (3-6 years). The shoots are plucked at regular intervals (6-25 days) and removed a certain amount of various elements from the plant-soil system (Verma, 1997). Certain major nutrients have to be supplemented through fertilizer application. Tea yield increases sharply with increased levels of N and K to a certain point (Barbora, 1996).

Tea being a leaf crop, in the flush shoot the nitrogen content is the highest followed by potassium (K), calcium (Ca), phosphorus (P), sulfur (S), magnesium (Mg) and zinc (Zn). Nitrogen (N) is an important constituent of plants parts and plays a vital role in the physiology of the tea plant. It is estimated that harvestable crop contains 3.5-5% N on dry matter basis (Verma, 1997). Although applications of N can increase tea yields, it is recognized that the quality of the manufactured product is suppressed by large N rates (Cloughly et al., 1983).

Potassium and magnesium are required in large quantities and they are both involved in almost all biological reactions. Potassium is the second major nutrient for tea after N and makes up 1.5-2% of the dry matter in tea leaves (Verma, 1997, 1993; Wu Xun etal.1997). Magnesium occupies up to 0.30% of the leaves dry matter in the fresh leaves (Wu Xun et al., 1997) . Potassium and magnesium deficiencies widely occur in the tea plantation regions mainly due to the higher precipitation and consequently higher leaching as well as the higher demands (Verma, 1997, Wu Xun et al., 1997). According to the reports of Guilan Agricultural Organization authorities potassium deficiency provided 90% of the cultivated region and magnesium deficiency exist the same degree in Guilan province (major tea plantation area). This huge amount of K and Mg depletion is mainly due to absence of K and Mg fertilizers among other fertilizers (unpublished data). Verma (1997) reported in most of tea orchards soil exchangeable potas-

*Corresponding author. E-mail: ramaftee@yahoo.com.

Table 1. Results of soil analysis in experimental plots.

Depth (cm)	pH	OM (%)	N (%)	Available P (mg/kg)	Available K (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
0-30	5.2	3.96	0.18	54.8	172	3.15	5.5

sium is lower than optimum and recommended potassium application for tea orchards. Bonheure and Willson (1992) resulted that response of potassium occur only whenever pH is lower than 5.2. Malakouti (1996) recommended potassium chloride application for Iranian tea orchards for increasing of plants resistance to pests, diseases and drought and improving of tea yield and quality. He reported that potassium chloride in some soil when chloride concentration is lower than 150 mg/kg will be used.

Zinc is not readily absorbed by tea from soil and its deficiency is not readily corrected by ground application of zinc compound. Foliar application is very effective. Copper is important for tea. It is an essential constituent of the enzyme polyphenol oxidase, which is vital for fermentation (Bonheure and Willson, 1992). The quality of made tea depends on organic and inorganic composition of harvested shoots, which are changed into the substances, these are responsible for taste, flavor and color of made tea. In this regard, balanced nutrition of tea is of particular importance to secure good harvested fresh leaves as a prerequisite for tea of superior quality (Wu Xun et al., 1997).

This study was conducted to find out effects of some fertilizers (two types N and K, Mg, Zn and Cu compounds) on quality and yield of Iranian tea in Guilan province.

MATERIALS AND METHODS

This experiment carried out in the Fashalem Tea Research Station, Fuman, Rasht, located in northern region of Iran. Soil analysis carried out on experimental tea plantation before start of trial (Table 1). The trial carried out by using factorial split-plot design, with three factors in three replications in RCBD. Nitrogen and potassium fertilizers, both distributed in factorial form with two levels into main plots and micronutrients (include of magnesium sulphate, zinc sulphate and copper sulphate) distributed in the sub-plots for better study. Each replication included sixteen treatments. Treatments were:

Factor A: two types N fertilizers including a_1: urea and a_2: ammonium sulphate (200 kg N/ha).
Factor B: two types K fertilizers including b_1: potassium sulphate and b_2: potassium chloride (120 kg K_2O/ha).
Factor C: micronutrients at four level including c_1: no micronutrient, c_2: magnesium sulphate, c_3: magnesium sulphate + zinc sulphate and c_4: magnesium sulphate + zinc sulphate + copper sulphate.

In this trial potassium, magnesium and nitrogen fertilizers used as soil application and micronutrients (Zn and Cu) sprayed on the foliage. Potassium, magnesium and nitrogen application carried out in two split and micronutrients foliar sprayed carried out in three split after leaves plucking. Amounts of fertilizers obtained on the base of plant uptake and soil analysis (Malakouti, 1996). Field practice, include of irrigation and pruning, pest and diseases management carried out as commonly during the experiment. Phosphorus fertilizer applied at the same amount in all plots. Flush leaves on the plucking table harvested by plucking machine and yield of each plots obtained by weighing of green leaves. Total yield in each plot also obtained from sum of ten times plucking. Quality of tea evaluated by measurement of caffeine, tannin and water extract percent (Bureau of Ceylon Standards 1968). Leaf nutrients content (including N, P, K, Mg, Zn and Cu) also measured by analysis of fresh leaves using Kjeltec, spectrophotometer, flame photometer and atomic absorption apparatuses. Statistical analysis of data carried out by MSTAT-C software. Means were separated using Duncan's multiple range tests. Transformation of percentage data did where appropriate.

RESULTS AND DISCUSSION

The effect of fertilizers on the experimental traits is showed in Table 2. The results revealed that micronutrients effects were significant on the yield (in ten times plucking) at 0.05. Based on results magnesium sulphate zinc sulphate was the best treatment for increasing of yield (Figure 1). Magnesium is the only mineral constituent in the chlorophyll molecule that regulates photosynthesis. In addition, it acts as an activator of many enzyme systems; also, zinc is necessary for the synthesis of indole acetic acid (IAA), which is responsible for active shoot growth (Verma, 1997). Since, Mg and Zn fertilizer application increased yield of tea leaves in our experiment. This result was same as Verma (1997) and Wu Xun et al., (1997) results.

Based on results, micronutrients application in tea plantation caused significantly increasing in P, Zn and Cu content of tea leaves (Table 2). Nitrogen fertilizers gave significantly ($P<0.05$) higher amounts of water extract and tannin percent which have made tea qualitative traits. Among N fertilizers, Urea was better than Ammonium sulphate to increase water extract and tannin. However, micronutrients + N + K treatment increased caffeine percent. Cloughley (1982) investigated factors influencing the caffeine content of tea. This increased in line with growth rate, which was increased by application of nitrogen and potash fertilizers. According to Verma (1997) ammonium sulphate is the superior source of N compared other sources. It not only provides ammonium, nitrate (after nitrification) and sulphate ions for tea nutriation, but also liberates nutrients from soil's reserves.

Micronutrient fertilizers increased amount of copper (Table 2). Combined of potassium chloride and urea with micronutrients was the best treatment in increasing of leaves copper content. This treatment that is micronu-

Table 2. Effect of fertilizers on the yield, nutrients and qualitative factors (Tannin, Caffeine and Water extract)

Fertilizers	Total yield (kg/12.5m^2)	Mean Square						
		Nitrogen %	Phosphorus %	Water extract %	Tannin %	Caffeine %	Zinc mg/kg	Copper mg/kg
N	5.45 ^{ns}	0.004 ^{ns}	0.002 ^{ns}	21.6 *	5.16 *	0.14 ^{ns}	15.2 ^{ns}	4.7 ^{ns}
K	0.13 ^{ns}	0.002 ^{ns}	0.00 ^{ns}	21.07 ^{ns}	0.27 ^{ns}	0.02 ^{ns}	111 ^{ns}	1.7 ^{ns}
N + K	68.33 ^{ns}	0.07 ^{ns}	0.00 ^{ns}	3.74 ^{ns}	0.03 ^{ns}	0.05 ^{ns}	9.2 ^{ns}	7.52 ^{ns}
Micronutrient	17.76 *	0.01 ^{ns}	0.003 **	1.06 ^{ns}	0.34 ^{ns}	0.04 ^{ns}	723.8 **	207.5 **
Micronutrient + N	0.06 ^{ns}	0.02 ^{ns}	0.001 ^{ns}	2.09 ^{ns}	0.52 ^{ns}	0.05 ^{ns}	17.2 ^{ns}	4.4 ^{ns}
Micronutrient + K	1.17 ^{ns}	0.09 **	0.00 ^{ns}	2.83 ^{ns}	1.20 ^{ns}	0.02 ^{ns}	87.6 ^{ns}	1.5 ^{ns}
Micronutrient + N + K	0.24 ^{ns}	0.03 ^{ns}	0.00 ^{ns}	0.37	0.33 ^{ns}	0.08 **	122.9 ^{ns}	2.2 ^{ns}
CV (%)	8.9	2.9	4.1	5.4	7.6	8.1	19.6	12.9

**: significant difference at 1%, *: significant difference at 5%, ns: non significant difference.

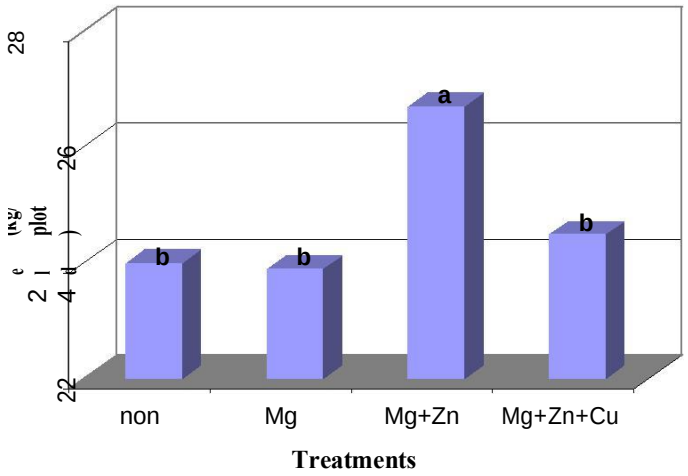

Figure 1. Effect of magnesium sulphate (Mg), zinc sulphate (Zn) and copper sulphate (Cu) on the tea yield (kg/ 12.5 m2)

trients + N + K improved both Cu and caffeine content of tea leaves. Copper is an essential constituent of the enzyme polyphenol oxidase, which is vital for fermentation (Bonheure and Willson 1992).

In conclusion, compound of magnesium sulphate + zinc sulphate fertilizers can increase tea plantation yield. Urea and potassium chloride compound can improve quality of tea (tannin and caffeine percent. Micronutrients application especially Cu and Zn are necessary to improving of fermentation process in black tea. According to Verma (1997), for greater efficiency, it is recommended that out of total N, 20% be in the form of ammonium sulphate, 65% in the form of urea and the remaining 15% in the form of ammonium nitrate. These results confirm that balanced nutrition including the nutrients N, K, Mg and micronutrients is an important measure to improve productivity and quality of tea.

REFERENCES

Barbora AC (1996). Integrated nutrient management for tea in north-eastern India. Fertilizer News. 41(12): 77-83.

Bonheure D, KC Willson (1992). Mineral nutrition and fertilizers. In: K.C. Willson and M.N. Clifford (eds.). Tea cultivation to consumption. Chapman and Hall. pp. 269-330.

Bureau of Ceylon Standards (1968). Standard methods for the analysis of black tea. Bureau of Ceylon Standards. Colombo. Seri Lanka.

Cloughly JB (1982). Factors influencing the caffeine content of black tea. Part1. The effect of field variables. Food chemistry. 9(4): 269-276.

Cloughly JB, Grice WJ, Ellis RT (1983). Effects of harvesting policy and nitrogen application rates on the production of tea in central Africa. I. yield and crop distribution. Exp. Agric. 19: 33-46.

Malakouti MJ (1996). Sustainable agriculture and yield increasing by balanced fertilization in Iran. Agric. Edu. Press. Iran. Karaj.

Ruan J, Härdter R (2001). Productivity and quality response of tea to balanced nutrient management – Examples from China tea gardens. Int. Potash Instu.

Verma DP (1993). Fertilizer management in tea. In: H.L.S. Tandon (ed.). Fertilizer Management in Commercial Crops. FDCO. pp. 148-175.

Verma DP (1997). Balanced fertilisation for sustainable productivity of tea. Fertilizer News. 42(4): 113-125.

Wu Xun J, Y Ruan, W Binghua (1997). Potassium and magnesium for better tea production.