EFFECT OF DIFFERENT NITROGENOUS FERTILIZERS ON THE GROWTH AND YIELD OF THREE YEARS OLD TEA (*Camellia sinensis*) PLANTS

Sair Sarwar, Fayaz Ahmad, F.S. Hamid, B.M. Khan & Faisal Khurshid

ABSTRACT

Effect of different nitrogenous fertilizers on the growth and yield of three years old tea (*Camellia sinensis* L) plants was investigated at National Tea Research Institute, Shinkiari, (Mansehra) during 2005-06. The nitrogenous fertilizers used were ammonium sulphate, calcium ammonium nitrate, urea and nitrophos along with control receiving no fertilizer. All the nitrogenous fertilizers were applied at the rate of 100 kg N acre^{-1} along with the constant doses of P and K (25 kg, 15 kg acre^{-1}, respectively). It was found that effect of all the fertilizers on increase of plant height, plant canopy, fresh tea leaves yield and made tea yield was non significant at 5% probability, however ammonium sulphate produced the highest increase in plant height (63.95 cm), plant canopy (3763.3 cm^2), fresh tea leaves yield (1695.50 kg acre^{-1}) and made tea yield (339.30 kg acre^{-1}) compared to the other fertilizer treatments. Regarding made tea yield, the response of other fertilizers was in the order of nitrophos (327.40 kg acre^{-1}), urea (322.80 kg acre^{-1}) and calcium ammonium nitrate (314.16 kg acre^{-1}) respectively. Minimum made tea yield (253.40 kg acre^{-1}) was recorded in control. Ammonium sulphate as a source of nitrogen (100 kg acre^{-1}) along with P (25 kg acre^{-1}) and K (15 kg acre^{-1}) is recorded for the best growth and yield of tea under the agro-climatic condition of Mansehra, Pakistan.

Keywords: *Camellia sinensis*, Nitrogen Fertilizer, Tea, Yield

INTRODUCTION

The tea plant (*Camellia sinensis* L) is an evergreen of Camellia family. It is originated in China and India (Elliot and Whitehead, 1996). The genus Camellia includes some 82 species, which are mostly indigenous to highlands of south India (Sealy, 1958). Under normal conditions the tea plant is an evergreen tree and widely grows into medium size tree but under cultivation it is pruned and trained as low spreading bush to ensure that a maximum crop of young shoots can be obtained (Hajra, 2001).

Pakistan is an agricultural country. It is bestowed with different agro-climatic conditions combined with soil of suitable physico-chemical properties. Under these diverse climatic conditions with different soils various crops, vegetables and fruits can be grown successfully. Fortunately, some of the areas of NWFP are feasible for tea cultivation due to its climatic and soil characteristics. These areas include the districts Mansehra, Batagram, Shangla and Swat. In these areas 1.5 lakh acres of land has been declared suitable for tea cultivation (Khan, *et al.* 2005)

Tea has begun as medicine and grew into one of the most important beverage of the world. Tea is taken both by poor and rich in Pakistan. Per capita consumption of tea in Pakistan is about one kilogram per annum. Economics revealed that 100 percent tea consumed in the country is imported, and presently Pakistan is the second largest importer of tea after United Kingdom (Amin, 1999). Pakistan imported 127194 tons of black tea during 2004-2005 costing Rs. 12.40 billion from different countries of the world with the largest share from Kenya. (NTRI Annual Report 2004-05). To meet the demand of rapidly increasing population of the country, Pakistan is expected to become the world largest tea importer by the year 2010 AD (Hussain, 1999-2000).

Fertilizer is one of the major agro-inputs contributing to the cost of production and productivity in tea plantation. For proper maintenance of the health of tea bushes and to obtain high yield, a well-balanced fertilization is necessary at certain intervals throughout the year. Nitrogen, potassium and phosphorous in that order are three major nutrients required for the cultivation and should be used in proper proportion. Ammonium sulphate and Urea consistently yield good result, except that they reduce the pH (causing acidity) in South India. Ammonium sulphate is the best for application during April – May and Urea is recommended during the preceeding months. Potassium and Nitrogen when applied together have a synergistic effect on tea. It has been shown that only in presence of adequate amount of potassium the best response of nitrogen is obtained. Potassium phosphates also have been shown to interact favorably (Subramaniam, 1995). For tea being leaf crop, nitrogen is probably the key element among the various essential elements in plant nutrition. Therefore nitrogen is of considerable importance in the vegetative growth of tea plant (Hajra, 2001).

The nitrogen uptake mechanisms by the tea plant has been studied and found that tea plant absorbed ammonium nitrogen more effectively than nitrate nitrogen (Ishigaki, 1978). In tea nitrogen is generally applied in the form of straight nitrogen compound. Among the various forms of nitrogen fertilizers, sulphate of ammonia showed to be the

most efficient and safe fertilizer for tea and was mainly used for several years. Its long continued use increases acidity of the soil (Gokhale, 1957) and creates problems of base deficiencies and manganese toxicity and recommended NPK fertilizer mixture in the ratio of 5:1:2 with 100-200 and 100-250kg N/ha/annum in south India and Kenya, respectively (Bonheure and Willson, 1992). Owuor (1985) reported that the commercial portion of tea crop consists of leaves and is therefore, highly responsive to application of nitrogen fertilizer.

Ranganathan *et al.* (1987) found that on soil of pH 5.0-5.5, yield responses decreased in order of sulphate of ammonia, calcium ammonium nitrate and urea. Using of sulphate of ammonia for 20 per cent of the nitrogen requirement was more economical than using only urea. Obatulu (1985) observed no significant differences between urea and sulphate of ammonia when it was used to manure one-year-old tea cuttings. Tea plant needs adequate supply of nutrients for its nourishment, growth, development and build up of organic tissues from simple inorganic substances. Meskhibze (1985) showed that ammonium sulphate produced a higher yield response than ammonium nitrate or ammonium carbonate. According to Honshina (1985) the Japanese farmers use 600 to 1000 kg N/ha evidently not for the yield but for the quality consideration. Sandanam *et al.* (1980) stated that until early eighties ammonium sulfate was extensively used as a source of nitrogenous fertilizer in fertilizer mixture in Sri Lanka. Lack or insufficient supply of nutrient particularly N increased dormancy resulting in poor growth (Kulasegaram and Kathiravetpilliai, 1972). In 1980, they also reported that when twice the recommended dose of N was applied to young tea, there was an initial increase in bud activity. Fernando *et al.* (1969) recommended a wide range of Nitrogen levels with sulphate of ammonia being the primary nitrogen source alongwith different levels of Potash as MOP for the four different climatic regions of Ceylon. Anonymous (1959) investigated and compared to urea, applications of sulphate of ammonia resulted in better cup characters with high valuation of tea.

In Pakistan, tea cultivation has been recently started. The prospective tea growing areas of Pakistan are ranging from 1000 to 2000 m with varying soil pH ranging from 5.0 to 6.5, the annual rainfall is more than 1000 mm with average temperature ranging 10.07 ^{o}C to 22.8 ^{o}C. The objective of this study is to find suitable nitrogenous fertilizer for the growth and yield of tea in Pakistan.

MATERIALS AND METHODS

This research study was conducted at National Tea Research Institute, Shinkiari (Mansehra) during 2005-06 on three years old tea plants (Variety Qi-men) with the objectives to find suitable nitrogenous fertilizers for the efficient growth and high yield of tea. Nitrogenous fertilizers i.e. Ammonium sulpahte, Calcium ammonium nitrate, Urea and Nitrophos were used as Nitrogen sources (100 kg N acre^{-1}) according to their calculated quantities. DAP and SOP was used as sources of P and K (25kg and 15 kg acre^{-1} respectively). DAP and SOP were applied as full doses along with the 1st dose of nitrogenous fertilizers at the start of experiment in March, 2005, while the 2nd and 3rd dose of nitrogenous fertilizer were applied in the months of June and September 2005, respectively. The details of treatments are as under.

T1: Control
T2: Ammonium Sulfate + DAP + SOP (NPK 100:25:15 Kg acre^{-1})
T3: Calcium Ammonium Nitrate+DAP+SOP(NPK 100:25:15Kg acre^{-1})
T4: Urea + DAP + SOP (NPK 100:25:15 Kg acre^{-1})
T5: Nitrophos + DAP + SOP (NPK 100:25:15 Kg acre^{-1})

The experiment was laid out in Randomized Complete Block Design with three replications. Tea plucking was done manually by keeping two leaves and a bud as a standard. Data was collected on increase in plant height (cm), increase in plant canopy (cm^2), fresh green leaves yield (kg acre^{-1}) and made tea yield (kg acre^{-1}). The data collected during the experiment was analyzed (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Increase in Plant Height

The mean values of different nitrogenous fertilizers (Table-I) indicated that the effect of fertilizers on the plant height was non-significant. The maximum increase in plant height (63.95 cm) was recorded in plots fertilized with ammonium sulfate along with constant doses of Diammonium phosphate and Sulfate of potash, followed by Urea (56.78 cm), while minimum increase in plant height (48.05 cm) was noted in control. As the commercial portion of the tea crop consists of leaves and is therefore, highly responsive to application of nitrogen fertilizers (Owuor, 1985). Acidic soil combined with suitable temperature and adequate rainfalls are considered the critical factors for successful cultivation of tea. As the use of ammonium sulfate increases acidity of the soil (Gokhale, 1957), therefore the maximum increase in plant height may be due to the acidic characteristics of soil created with the application of ammonium sulfate.

Increase in Plant Canopy

Increase in plant canopy in three-year-old tea plantation was non-significant for the different combinations of nitrogenous fertilizers (Table-I). The maximum increase in plant canopy (3763.3 cm^2) was recorded by T2 (Ammonium sulphate + DAP+ SOP) followed by T4 (3073.3 cm^2) and T3 (3055.1 cm^2) respectively. As mentioned earlier Ammonium Sulphate increases the acidity of soil by providing favourable conditions for the growth of tea plants, therefore maximum plant canopy in the plots fertilized with ammonium sulphate may be due to the beneficial affects of the fertilizer compared to other treatments. As tea plant needs adequate supply of nutrients for its nourishment, growth and development and build up of organic tissues from simple inorganic substances, lack of sufficient supply of nutrients particularly N increase dormancy resulting in poor growth, therefore, increase in plant canopy may also be due to initial increase in bud activities due to application of fertilizer (Kulasegaram and Kathiravetpillai, 1970,1980). Fernando *et al.* (1969) recommended sulphate of ammonia as the primary nitrogen source along with different levels of potash as MOP for different climatic regions of Ceylon.

Fresh Leaves Yield

It is evident from Table-I that maximum fresh leaves yield (1695.5 kg $acre^{-1}$) was produced by ammonium sulphate + DAP + SOP while minimum yield was recorded in control (1267.0 kg $acre^{-1}$) receiving no fertilizer, however, the fresh leaves yield among the different fertilizers was non significant. As the plants fertilized with ammonium sulphate give the highest plant height and maximum increase in plant canopy, consequently the fresh leaves yield was the highest in this treatment. These results coincide with the findings of Bala Subramanium (1995), who reported that ammonium sulphate and urea consistently yield good result in presence of adequate amount of potassium. Obatulu (1985) also observed no significant difference between urea and sulphate of ammonia when it was used to manure on one-year-old tea cuttings.

Made Tea Yield

Like other parameters made tea yield was also highest (339.30 kg $acre^{-1}$) in the plots receiving ammonium sulphate fertilizer along with the constant doses of DAP and SOP (Table-I). In the remaining treatments made tea yield was higher in plots receiving Nitrophos (327.40 kg $acre^{-1}$) than Urea (322.80 kg $acre^{-1}$) and calcium ammonium nitrate (314.6 kg $acre^{-1}$). Minimum made tea yield (253.40 kg $acre^{-1}$) was recorded in control. The differences regarding made tea yield in all the treatments were non significant. The results are in close conformity with the findings of Ranganathan *et al.* (1987) who reported that the yield responds decreased in order of sulpahte of ammonia, calcium ammonium nitrate and urea on soil of pH 5.0—5.5. Meskhidze (1985) investigated that ammonium sulphate produced a higher yield response than ammonium nitrate or ammonium carbonate. It has also been reported that compared to urea, applications of sulphate of ammonia resulted in better cup characters with high valuation of tea (Anonymous, 1959).

CONCLUSION AND RECOMMENDATIONS

On the basis of the findings of this study, it was concluded that nitrogen in the form of ammonium sulfate (100 kg $acre^{-1}$) gave the encouraging results. Though the results were non-significant, the maximum leave yield, increase in plant height and its canopy and made tea produce were observed by the application of nitrogen in the form of ammonium sulfate under the climatic conditions of Mansehra, Pakistan. This might be due to acidifying characteristics of fertilizer, which is the basic requirement for the growth of tea crop.

Table-I: ***Effect of different nitrogenous fertilizers on the growth and yield of three-year old tea (Camellia sinensis) plants.***

Treatment	Plant height (cm)	Plant canopy (cm^2)	Fresh leaves yield (Kg $acre^{-1}$)	Made tea yield (Kg $acre^{-1}$)
T1	48.05	2490.8	1267.0	253.40
T2	63.95	3763.3	1695.5	339.30
T3	52.59	3055.1	1573	314.6
T4	56.78	3073.3	1614.0	322.80
T5	55.31	2475.4	1636.70	327.40
LSD	**NS**	**NS**	**NS**	**NS**

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