STUDIES ON THE EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON DROUGHT INFLUENCED PARAMETERS IN TEA (*Camellia* SP.)

Abstracts

Investigation was conducted at Parry Agro Industries Ltd., Valparai, Coimbatore district in two varieties of tea *viz.*, Assam jat and ATK clone. Totally eighteen treatments with different combinations of 100, 75, 62.5 and 50 per cent of the recommended doses of fertilizers along with DCC and biofertilizers were involved in the study. The DCC at the rate of three and six tonnes ha^{-1} and biofertilizers *viz.,* VAM, *Azospirillum* and Phosphobacteria each @ 50 kg ha^{-1} were given annually. The proline content and epicuticular wax content were generally found to be lower in DCC treated plots than rest of the plots in both Assam jat and ATK clones. The treatments T_3, T_4, T_5, T_8, T_{12} and T_{16} registered significantly lower proline and epicuticular wax content than estate practices alone at all levels (T_1, T_6, T_{10} and T_{15}). Biofertilizers alone (T_9, $T`_3$, T_{17} and T_{18}) did not affect the proline content in both the varieties during both the years. In both the varieties, T_3 and T_5 showed the maximum relative water content, transpiration rate and stomatal conductance closely followed by T_8 and T_{16} that received higher level of DCC when compared to estate practice alone.

Key words: DCC, Biofertilizers, Drought, Assam Jat and ATK

Introduction

In a rainfed crop like tea, grown mainly in hilly terrains of South India, success of plantation could naturally depend on adequate and uniformly distributed rainfall and soil moisture content. As application of DCC and VAM is known to increase the soil moisture content, it is presumed that they might also induce drought tolerance. Tea is a non-leguminous crop that hosts colonizingasymbiotic nitrogen fixers and phosphate-solubilizing bacteria in its rhizosphere. The increased uptake of nutrients from soil due to the application of chemical nutrientsand biofertilizers might have produced enough carbohydrate in leaves for translocation to thesink for maximum productivity (Chen et al., 2017). The proline accumulation, epicuticular wax present in the leaves, relative water content, transpiration rate and stomatal conductance which are the indices of drought tolerance, were taken up in the present study during two consecutive years, so as to understand the influence of DCC and biofertilizers.

Materials and Method

The field trial was conducted during in Parry Agro Industries Ltd., Valparai, Coimbatore district to study the effect of digested coirpith compost (DCC) and biofertilizers on two varieties of tea *viz.*, Assam jat and ATK clone. Totally eighteen treatments (Table 1) with different combinations of 100, 75, 62.5 and 50 per cent of the recommended doses of fertilizers along with DCC and biofertilizers constituted the study. The entire experiment was laid out in RBD with three replications. There were 100 tea bushes in each treatmental unit. DCC at the rate of three and six tonnes ha^{-1} and biofertilizers *viz.*, VAM, *Azospirillum* and Phosphobacteria each @ 40 kg ha^{-1} were given annually. The observations on drought influencing parameters viz., proline accumulation, epicuticular wax, relative water content, stomatal resistance, transpiration rate and photosynthetic rate were registered during two drought seasons Estimation of proline in freshly plucked shoots was done as per the method described by Bates *et al.* (1973).

Epicuticular wax formation was quantified as per the methods standardized by Ebercon *et al*. (1977). The relative water content in freshly plucked shoots was estimated as per the relative turgidity technique described by Barrs and Weatherley (1962) and expressed in percentage. Stomatal resistance and transpiration rate were measured by using Licor 302 in the third leaf of pluckable shoots and expressed as μmole m^{-2} s^{-1}. The sampling was done between 9 a.m. and 10 a.m.

Results and Discussion

Proline content, epicuticular wax content, relative water content, transpiration rate and stomatal conductance differed significantly among the treatments in both the varieties studied. The proline content and epicuticular wax content were generally found to be lower in DCC treated plots than rest of the plots in both Assam jat and ATK clones. The treatments T_3, T_4, T_5, T_8, T_{12} and T_{16} fairly registered significantly lower proline and epicuticular wax content than estate practices at all levels (T_1, T_6, T_{10} and T_{15}). Biofertilizers alone (T_9, T\`$_3$, T_{17} and T_{18}) did not affect the proline content in both the varieties during both the years. In both the varieties, T_3 and T_5 showed the maximum relative water content, transpiration rate and stomatal conductance closely followed by T_8 and T_{16} whose received higher level of DCC when compared to estate practice alone.

The results clearly showed that wherever DCC was applied, there was relatively lesser proline and epicuticular wax content, indicating that the soil moisture conserved in DCC treated plots might be responsible for lesser proline accumulation in these plants. The effect of VAM on growth during drought is attributed to the ability of VAM hyphae to take up water that is unavailable to the plant roots (Thomas *et al*., 1993).

In the present study, combined application of DCC and biofertilizers increased the relative water content, transpiration rate and stomatal conductance as compared to control. Application of DCC, because of its sponge like nature, helps to retain water and supplies to the plants during drought period. This makes the plants to have higher relative water content, stomatal conductance and transpiration rate. Similar studies with rice straw has documented that adequate supply of K has an important role in the water relation of plants. It is also known that K plays a specific role in most plant species in the opening of stomata and that better K^+ nutrition tended to increase the water content of tissues (Lalani Samarappuli *et al*., 1998).

The role of biofertilizers in enhancing drought tolerant nature of the plants has been well documented. Inoculation of *Azospirillum* enhanced the production of plant growth substances, which might have induced proliferation of root growth providing maximum surface area for the absorption of water (Govindan and Vikraman Nair, 1983) and helps in improved relative water content of the plant. The role of VAM is well known in uptake and translocation of water and nutrients, hence biofertilizers inoculated plots generally had better ability to withstand drought (Merina Premkumari and Balasubramanian, 1993). Okon *et al*. (1998) observed higher stomatal conductance and lower canopy temperature in inoculated plants under stress than in non-irrigated controls. This could be attributed to the role of *Azospirillum*, which extracted more soil water, particularly from deeper layers, improving the soil moisture utilization of the host plant. During natural drought, the net photosynthetic rate, stomatal conductance and transpiration rate decreased gradually with declining soil water potential (Lin Jinke, 1998), but in the present study, DCC applied plants registered increased net photosynthetic rate, stomatal conductance and transpiration rate than the estate practice.

Conclusion

The present findings showed that proline accumulation and epicuticular wax content had significant negative correlation with relative water content, transpiration rate, stomatal conductance and photosynthetic rate which are also in conformity with earlier studies by Rajagopal *et al*. (1991) and Voleti *et al*. (1990) who observed a clear negative relationship between epicuticular wax content and relative water content and transpiration rate. Higher relative water content of leaf was also associated with lower proline content in cocoa (Balasimha, 1982).

Thus addition of organic manures i.e. DCC and biofertilizers enhanced the relative water content of the plants which in turn inhibited the proline accumulation and epicuticular wax content of the leaves and persuade the plants to tolerate drought.

REFERENCES

Balasimha, D. 1982. Leaf growth and associated physiological changes in six cacao accessions under water stress. **PLACROSYM-V,** pp. 224-230.

Barrs, H.D. and P.E. Weatherley (1962). A re-examination of the relative turgidity technique for estimating water deficit in leaves. **Aust. J. Biol. Sci., 15:** 413-408

Bates, L.S., R.P. Waldren and I.D. Teare (1973). Rapid determination of free proline for water stress studies. **Plant and Soil, 39 :** 205-207.

Ebercon, A., A. Blum and W.R. Jardan (1977). A rapid calorimetric method for epicuticular wax content of sorghum leaves. **Crop Sci., 17:** 179-180.

Govindan, M. and R. Vikraman Nair (1983). Studies on the occurance of nitrogen fixing bacteria, *Azospirillum* in the root environment of cocoa. **PLACROSYM-VI,** 255-260.

Lalani Samarappuli, N. Yogaratnam, P. Karunadasa and U. Mitrasena (1998). Effect of mulching with rice straw soil chemical properties and its influence on the performance of *Hevea.* **J. Rubber Res., 1(4):** 263-77.

Lin Jinke (1998). Effect of water stress on the photosynthesis of tea. **J. Fujian Agric. Univ. 27 (4):** pp. 423-427.

Merina Premkumari, S. and A. Balasubramanian (1993). Effect of combined inoculation of VAM and *Azospirillum* on the growth and nutrient uptake by coffee seedlings. **Indian coffee, 56 (12):** 5-11.

Okon, Y., P.G. Heytler and R.W.F. Hardy (1998). *Azospirillum* as potential inoculants for agriculture. **Trends Biotechnol.3 :** 223-228.

Rajagopal,V., S.R. Voleti, K.V. Kasturi Bai and S. Shivasankar (1991). Physiological and biochemical criteria for breeding drought tolerance in coconut. **In:** Coconut breeding and management, (Eds.) E.G. Silas, Kerala Agricultural University, Vellanikkara, Trichur, pp 136-143.

Thomas, G.V., V. Rajagopal and B.M. Bopaiah (1993). VA-Mycorrhizal association in relation to drought tolerance in coconut.**J. Plantation Crops (supplement) 21:** 98-103.

Voleti, S.R., K.V. Kasturi Bai, V. Rajagopal and S. Shivashankar (1990`). Relative water content and proline accumulation in coconut genotypes under moisture stress. **J. Plantation Crops. 18(2):** 88-95.

Chen DI, Shen J, Zhao W, Wang T, Han L, Hamilton JL, Im HJ. Osteoarthritis: toward a comprehensive understanding of pathological mechanism. Bone research. 2017 Jan 17;5(1):1-3.

Table 1. Treatment details.

Treatments	Details
T_1	Recommended dose of inorganic fertilizers (Estate practice or control)
T_2	T_1 + Digested Coirpith Compost (DCC) alone @ 3 t/ha
T_3	T_1 + Digested Coirpith Compost (DCC) alone @ 6 t/ha
T_4	T_2 + Biofertilizers
T_5	T_3 + Biofertilizers
T_6	75% of T_1
T_7	75% of T_1 + DCC @ 3 t/ha + Biofertilizers
T_8	75% of T_1 + DCC @ 6 t/ha + Biofertilizers
T_9	75% of T_1 + Biofertilizers alone
T_{10}	62.5% of T_1
T_{11}	62.5% of T_1 + Biofertilizers
T_{12}	62.5% of T_1 + DCC @ 6 t/ha + Biofertilizers
T_{13}	62.5% of T_1 + Biofertilizers alone
T_{14}	50% of T_1
T_{15}	50% of T_1 + DCC @ 3 t/ha + Biofertilizers
T_{16}	50% of T_1 + DCC @ 6 t/ha + Biofertilizers
T_{17}	50% of T_1 + Biofertilizers alone
T_{18}	T_1 + Biofertilizers alone
Biofertilizers - VAM, *Azospirillum* and Phosphobacteria each @ 40 kg/ha	

Table 2. Effect of digested coirpith compost and biofertilizers on drought influenced characters in tea varieties

Treatments	**Proline (μm g^{-1})**		**Epicuticular wax (μg cm^{-2})**		**Relative water content (%)**		**Transpiration rate (μmole m^{-2} s^{-1})**		**Stomatal conductance (milli mole m^{-2} s^{-1})**		**Photosynthetic rate (milli mole m^{-2} s^{-1})**	
	ATK	**Assam**	**ATK**	**Assam**	**ATK**	**Assam**	**ATK**	**Assam**	**ATK**	**Assam**	**ATK**	**Assam**
T_1	1.51	1.63	122	129	81.0	81.2	0.28	0.37	1.9	2.50	8.55	8.05
T_2	1.40	1.465	115	123	84.2	82.0	0.29	0.41	2.1	2.65	9.10	8.65
T_3	1.19	1.255	112	117	84.3	84.0	0.37	0.44	2.6	2.90	10.30	9.05
T_4	1.32	1.42	115	123	83.8	83.1	0.32	0.41	2.4	2.80	9.70	8.75
T_5	1.18	1.27	111	118	85.3	84.7	0.36	0.44	2.7	2.95	10.50	9.15
T_6	1.46	1.615	122	128	80.5	81.0	0.27	0.38	2.1	2.65	8.65	8.25
T_7	1.34	1.42	115	119	82.5	83.3	0.34	0.41	2.5	2.80	9.40	8.85
T_8	1.13	1.28	112	117	83.1	84.3	0.36	0.43	2.8	3.10	10.45	9.20
T_9	1.45	1.63	119	125	82.1	82.9	0.27	0.40	2.1	2.60	8.70	8.40
T_{10}	1.49	1.595	123	128	81.8	81.7	0.26	0.36	2.0	2.50	8.70	8.45
T_{11}	1.36	1.48	113	122	84.2	82.2	0.27	0.40	2.3	2.80	9.40	8.80
T_{12}	1.17	1.285	109	118	84.5	84.3	0.32	0.42	2.7	3.00	10.05	9.10
T_{13}	1.44	1.585	121	126	80.3	81.2	0.31	0.38	2.0	2.70	9.05	8.50
T_{14}	1.48	1.605	123	128	80.6	81.2	0.26	0.37	1.8	2.35	8.65	8.25
T_{15}	1.23	1.4	114	120	80.9	84.7	0.33	0.41	2.5	2.85	9.55	8.75
T_{16}	1.19	1.305	109	120	82.0	84.3	0.35	0.41	2.6	2.90	9.80	8.90

T_{17}	1.52	1.655	118	131	80.5	81.1	0.27	0.37	1.8	2.50	8.80	8.15
T_{18}	1.47	1.62	118	127	80.8	81.1	0.28	0.39	2.0	2.65	9.10	8.40
S.Ed	0.064	0.071	2.329	2.411	1.212	1.205	0.015	0.019	0.120	0.146	0.590	0.524
CD (P=0.05)	0.129	0.144	4.733	4.899	2.464	2.448	0.030	0.038	0.244	0.297	1.200	1.066