Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(5): 908-910
Received: 22-07-2019
Accepted: 24-08-2019

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Correlation studies of *Bt* cotton in Jewargi Taluka, Kalaburagi district

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Abstract
A study was undertaken in *Bt* cotton growing soils of Jewargi taluka of Kalaburagi district in 2017-18 to study the correlation between nutrient status and spectral characteristics of *Bt* cotton the results revealed that the normalized difference vegetation index values was significant and positive correlation with petiole nitrogen and phosphorus while it had a significant negative correlation with only petiole manganese. However, other nutrients content in petiole like K, Ca, Mg, S, Fe, Cu and Zn were showed the non significant relation. Available nitrogen had significant and positive correlation with nitrogen, phosphorus and sulphur in leaf petiole. The available phosphorus had significant and positive correlation with phosphorus in leaf petiole while it had negative significant relation with the calcium, copper and zinc Available iron has non-significant relation with P, Mg, S and Zn content in leaf petiole.

Keywords: Micronutrients, corelation, NDVI and spectral indices

Introduction
Cotton (*Gossypium* spp.) the 'king of fibers' also popularly known as the 'white gold' enjoys a pre-eminent position amongst cash crops in the world and in India as well. It is the nature's most precious gift to the mankind, contributed by the genus *Gossypium*. Globally, cotton is cultivated in 70 countries with a total coverage of 32.3 million ha (Anonymous, 2016) [1].
The black cotton soils are mostly deficient in nitrogen, inorganic phosphorus and organic matter but rich in potash, calcium, magnesium and iron. Cotton on these soils is mostly grown under rainfed conditions. The red soils are light, porous and friable. They are deficient in nitrogen, humus, inorganic phosphorus and lime but rich in iron. The nutrient supply is the second most important limiting factor in cotton production only after water. Most often soils in the rainfed areas are not only thirsty but also hungry. It is a well established fact that adequate quantities of nutrients are needed for achieving high yields. Cotton plant being a heavy feeder, needs proper supply of plant nutrients for its successful cultivation. It showed better response in general to N and P while in particular to K in deficient soil. Hence, adequate supply of fertilizers and manures is essential to sustain high seed cotton yields. Keeping the above aspects and said constraints in view, there is need to scientifically analyse and statistically correlate between soil physical, physico-chemical characteristics and chemical properties of the soils.

Materials and Methods
A study was undertaken in *Bt* cotton growing soils of Jewargi taluka of Kalaburagi district in 2017-18 to study the leaf nutrient status and spectral characteristics of *Bt* cotton. The surveyed area was *Bt* cotton growing farmers fields in Jewargi taluka is located between 16^0 54' 14.5" and 17^0 02' 12.9" N latitude and between 76^0 46' 18.4" and 76^0 77' 39.5" E longitude and at an altitude on an average of 393 m above mean sea level of North Eastern Dry Zone of Karnataka.
For identification of soil fertility constraints and to relate soil fertility with plant nutrient status, one hundred surface soil samples (0-30 cm) were collected from the fields where cotton petiole samples were collected. Exact geographical locations of surface soil samples were recorded using a GPS (Geographical Positioning System) device. Collected soil samples were analyzed for pH (1:2.5), EC (1:2.5), OC, available N, P, K, S, Fe, Mn, Cu, Zn and exchangeable Ca and Mg.
Correlation relation was built between leaf nutrient status and spectral indice with soil available nutrient status. Correlation coefficients (r) were calculated in SPSS package and tests of significance were applied as per the procedure outlined by (Gomez and Gomez, 1984) [2].

Results and Discussions

Correlation of spectral indices with nutrient content in leaf petiole of *Bt* cotton

Data depicted in the table 1 shows that, normalized difference vegetation index (NDVI) values was significant and positive correlation with petiole N (r = 0.728**) and P (r = 0.243*) while it had a significant negative correlation with only petiole Mn (r = -0.202*). However, other nutrients content in petiole like K, Ca, Mg, S, Fe, Cu and Zn were showed the non significant relation with NDVI readings. As the nitrogen content in petiole increases the NDVI readings also was increased, confirming prominent role of nitrogen in chlorophyll synthesis and vegetative growth (biomass) of crop so that results obtained concluded that green seeker will helpful for identifying the nitrogen stressed crop with the well fertilized crop. Similar results were observed by Read *et al.* (2002) [3]. Li *et al.* (2001) [4] reported that NDVI calculated from reflectance at 2m above the cotton canopy was positively correlated with biomass and lint yield. Among the abiotic factors that influence growth and development of the crops, nutrient stress is one of the important growth and yield limiting factor (Gole *et al.,* 2008) [5]. Most of the studies on nutrient deficiencies have been concentrated on spectral reflectance in relation to nutrient supply. In a nutrient deficient crop because of the low chlorophyll content, the red reflectance is much higher compared to that in the infra red region. Different vegetation indices like NDVI based on red and infra red reflectance have been developed as spectral parameters for distinguishing crop canopy under fertilized and nutrient stressed condition. This derived spectral indices are in agreement with the important biophysical parameters of the plant like leaf area, leaf area index, leaf area duration, chlorophyll content, dry matter production and these attributes were positively correlated with ultimate economic part of crop production in an agro-eco system.

Correlation of soil fertility status and *Bt* cotton leaf petiole nutrient content

Data presented in the Table 2 revealed that major, secondary and micro nutrients show significant and positive correlation with respective nutrient status in leaf petiole samples of *Bt* cotton except sulphur and manganese. Among the major nutrients, available nitrogen had significant and positive correlation with phosphorus (r=0.331**), sulphur (r=0.251*) and copper (r=0.209*) and also shows the significant and negative correlation with only manganese (r=-0.207*). The available phosphorus had negative and significant relation with the calcium (-0.390**), copper (r=-0.627**) and zinc (r=-0.717*), furthermore, available potassium had significant and positive correlation magnesium (r=0.253*) and zinc (r=0.199*) but it had significant negative correlation with calcium (r=-0.217*) and manganese (r=-0.306**). As the vegetative growth increased by the native soil N will contributed to easy upake of other nutrients in plants.

Among secondary nutrients, exchangeable calcium had significant and positive correlation existed between potassium (r=0.300**), magnesium (r=0.494**) and zinc (r=0.204*) while it had negative significant correlation existed with phosphorous (r=-0.202*), iron (r=-0.409**) and manganese (r=-0.718**). Exchangeable magnesium had negative significant relation with potassium (r=-0.198*), calcium (r=-0.222*), manganese (r=-0.254*) and copper (r=-0.235*). Available sulphur in the soil was not significantly associated with other leaf nutrients except with nitrogen (r=0.197*) and zinc (r=0.195*). Higher native Ca and Mg contributed to their higher content in plant petiole.

Among micronutrients, Available iron was showed the significant and positive relation for nitrogen (r=0.236*), potassium (r=0.290*), calcium (r=0.250*), manganese (r=0.245*) and copper (r=0.226*) content in leaf petiole due synergistic relation between N and Fe. Furthermore, manganese present in the soil was showed the non-significant relationship with all the nutrients which were present in petiole. Available copper was borne positive significant relation with Ca (r=0.277**) while it had negative significant correlation with potassium (r=-0.231*), and manganese (r=-0.238*). Lastly the available zinc possessed significant and negative relation with copper (r=-0.199*).

The leaf petiole concentrations of all the nutrients (major, secondary and micro nutrients) were positively and significantly correlated with available nutrients content of soils which were on confirmation of the findings of Srinivas *et al.* (1998) [6] wherein an increase in leaf petiole nutrient concentration with an increase in available nutrient status of soil was observed. Further the leaf Mn concentration were negatively and significantly correlated with soil N. leaf petiole content of P was positively correlated with both available N and P. Soil Ca was negatively and significantly correlated with leaf P, Mn and Fe, Similar findings were reported by Sagare *et al.,* (2001) [7]. Soil Mg was positively and significantly correlated with leaf Mg. Which was also on confirmation of the findings of Ramesh Kumar (1992) [8]. Soil Cu was negatively and significantly correlated with leaf Mn. Soil P was negatively and significantly correlated with leaf Zn due to the antagonistic effect. These findings were in conformity with those of Srinivas *et al.,* (1998) [6].

The non significant relationship has also observed between the major, secondary and micronutrients of soil with some leaf petiole nutrients of *Bt* cotton. These non significant type of results are supported by the findings of Mukhesh Kumar *et al.* (2017) [9] who reported that Nitrogen content in mustard crop has found non-significant and positive correlation with N (r=0.031), P(r=0.014), K (r=0.073), Zn (r= 0.220), Fe (r= 0.099) and Mn (r= 0.077) of soils. The presence of non-significant correlation indicates that not only the soil nutrient content, but also some other factors might have caused the poor interaction. In general, low to no nutrient application rate, mobility of nutrients in the soil, the ionic imbalance, fixation and soil pH as well as genetic variability might be responsible for the non-significant correlation between tissue and soil nutrient concentration. Further investigation is necessary in this regard, which may explain the relationship between available nutrients content in soil and uptake of nutrients by *Bt* cotton.

Table 1: Correlation between spectral indices vs nutrient content in leaf petiole of *Bt* cotton

Spectral Indice	Leaf petiole nutrients (r)									
	N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn
NDVI	0.728**	0.243*	0.094	-0.037	-0.028	0.101	-0.021	-0.202*	-0.043	0.092

Table 2: Correlation between leaf nutrient status vs soil fertility status

Soil available nutrients	Nutrients in Leaf petiole (r)									
	N	**P**	**K**	**Ca**	**Mg**	**S**	**Fe**	**Mn**	**Cu**	**Zn**
N	0.616**	0.331**	0.167	0.054	0.016	0.251*	0.064	-0.207*	0.209*	0.079
P	-0.167	0.211*	-0.054	- 0.390**	-0.032	-0.031	0.108	0.073	-0.627**	-0.717**
K	-0.158	0.008	0.291**	-0.217*	0.253*	0.026	0.159	-0.306**	-0.161	0.199*
Ca	0.028	-0.202*	0.300**	0.299**	0.494**	0.119	-0.409**	-0.718**	0.027	0.204*
Mg	-0.187	0.075	-0.198*	-0.222*	0.216*	0.041	-0.049	-0.254*	-0.235*	-0.025
S	0.197*	0.084	-0.028	0.099	0.030	0.164	-0.118	0.107	0.074	0.195*
Fe	0.236*	-0.111	0.290**	0.250*	-0.189	0.020	0.210*	0.245*	0.226*	0.066
Mn	0.136	-0.024	0.039	0.068	0.139	0.114	-0.053	0.062	0.023	0.165
Cu	0.194	-0.001	-0.231*	0.277**	-0.110	0.139	-0.181	-0.238*	0.201*	0.052
Zn	0.133	0.058	0.012	0.175	0.026	0.189	-0.061	-0.130	-0.199*	0.500**

Note
**. Correlation is significant at the 0.01 level *. Correlation is significant at the 0.05 level

Conclusion

Based on correlation studies, the following trends brought out. Leaf N, P and K were positively and significantly correlated with respective available nutrient content of the soils. Leaf N was positively and significantly correlated with available N, S and Fe. Leaf P was positively and significantly correlated with available N and P but negative and significant correlation with the exchangeable Ca. Leaf K was signicant and positive correlation with available K, Fe and with exchangeable Ca but negative and significant relation with available Mg and Cu. The NDVI developed significant and positive correlation with leaf petiole content of N and P but negative significant correlation with Mn. However, NDVI had weak relationship with plant K, S and Zn content of *Bt* cotton crop.

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