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PHYSICO-CHEMICAL ANALYSIS OF RHIZOSPHERIC SOIL OF MAIZE (*Zea mays* L.) AND ITS EFFECTS ON MAIZE DISEASE INCIDENCE (*IN VIVO*) IN KARNATAKA

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Rhizosphere of soil is a dynamic soil environment that supplies all the essential nutrients for crops. Soils differ in their physico-chemical properties and their ability to meet plant requirements. For agricultural sustainability, understanding the distribution and characteristics of soil is important (Louis, 2010). The availability of nutrients to the plant is very high in rhizospheric soil and soil pH is low than non-rhizospheric soil (Curl and Truelove, 1986; Marschner, 1995; Mishra *et al.,* 2015). Soils with high natural fertility can produce more crop yields without adding any fertilizers and farmers achieve higher yields with additional supply of critical nutrients (Louis, 2010). In rhizospheric soil, living plant roots interact with surrounding mineral, organic and microbial components of the soil (Curl and Truelove, 1986). These interactions play significant role in determining plant nutrition and growth (Robert and Berthelin, 1986).

Maize (*Zea mays* L.) is one of the most important cereal crops in the world agriculture as food, feed and industrial raw material. Maize is an exhaustive crop for macronutrients particularly potassium (Patil *et al.,* 2007). Deficiency of any of these nutrients can reduce yields and produce deficiency symptoms. Moreover, the symptoms of disease and deficiency of nutrition are affected by environmental factors. Nutrient deficiency not only forms the symptoms on plant but also causes plants to become more susceptible to various diseases. Excess of nutrition causes toxicity symptoms on plants. The best way to determine the level of nutrients available in the soil is through soil testing. The use of soil tests can help to determine the status of plant available nutrients to develop fertilizer recommendations to achieve optimum crop production and manage the disease infections caused by various pathogens. The control of disease infection and increase in yield of the crop determine the profit potential for farmers.

Soil organic carbon (SOC) is important parameter of soil fertility (Brady and Weil, 2008). SOC improves soil physical, chemical and biological properties and thus soil health. Passive and active mechanisms of disease control are activated through nutrient management of soil. Mineral nutrients are the components of plants and regulate metabolic activity associated with resistance of a plant to various pathogens and virulence of a pathogen to cause the disease. Adequate nutrition supply to plants is required to maintain a high level of disease resistance (Huber and Haneklaus, 2007). Soil electrical conductivity (EC) is a measurement that correlates with soil properties determining crop productivity (i.e., soil texture, cation exchange capacity, drainage conditions, organic matter level, salinity and sub soil characteristics). EC is the most common measure of soil salinity.

In the present investigation, soil sample collection were carried out in 16 districts of Karnataka, then the collected soil samples were subjected to analysis of N, P, K, EC, pH and SOC. Analysis of the percentage disease incidence in each field to estimate the effects of nutrients on plant growth (particularly on maize) was also undertaken. During field visit, on-farm disease scoring was carried out for the disease impact on maize crop. Among the major diseases of maize crop, two diseases stem rot and cob rot, were noticed to be predominantly present in fields and these had significant impact on yield loss. To confirm the yield loss due to diseases, infected plant parts were also collected to isolate pathogens.

This study was conducted in 16 districts of Karnataka including Chamarajanagara, Mysore, Thumkur, Chitradurga, Bellary, Bijapur, Koppal, Gadag, Hubli, Shimoga, Hassan, Gulbarga, Bidar, Raichur, Chikkaballapura and Bangalore rural. The soil samples were collected from farmlands at a depth of 1-12 cm and within 15 cm circumference of the plant stem during the *rabi* season of 2014 and 2015 by random soil sampling methods. Clean plastic pails were used to collect and store samples.

The soil samples were air-dried, crushed and then mixed thoroughly to obtain a homogenous mixture for each sample separately. Further, collected soil samples were analyzed for NPK, electrical conductivity, SOC and pH. The soil nitrogen was analyzed by Kjeldal method, phosphorous by Spectrophotometric method and potassium by flame photometer (ELICO). Soil pH and EC were determined using digital electronic pH meter and electrical conductivity meter, respectively. The SOC was estimated by Walkley-Black titration method.

Calculation of disease incidence

To record disease damage in fields, Z- shape field surveys were carried out. For disease scoring purpose, 1-9 scale method was adopted and the disease incidence was calculated by using the following formula:

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Percentage disease incidence (PDI) = (No. of infected plants/ Total no. of observed plants)× 100

To confirm the disease incidence in the field, the collected infected parts (leaf and seeds) were subjected to isolation of the pathogens in *in vitro*. The results obtained from this work were subjected to statistical analysis. All results were expressed as mean value ± SD. The statistical package SPSS was used for data description and analysis.

The results of fertility analysis are tabulated in Table 1. The highest nitrogen content of soil (107.5+1.2 kg/acre) was reported in Chikkaballapura district, followed by Bidar (106.7 ± 1.4 kg/acre) and Raichur (106.1 ± 2.4 kg/acre) and lowest nitrogen content was reported in Chamarajanagara district (89.6 ± 1.5 kg/acre). With respect to P content, highest was reported in Raichur (1.06 ± 0.10 kg/acre) followed by Bellary (0.98 ± 0.17 kg/acre) and Shimoga (0.73 ± 0.04 kg/acre) and lowest phosphorous content reported in Bidar (0.33 ± 0.03 kg/acre). Similarly, potash content of the soils was very high in Chikkaballapura (32.45 ± 2.57 kg/acre), followed by Mysore (30.48 ± 3.68 kg/acre) and Bidar (28.07 ± 1.75 kg/acre) and lowest level of potash was observed in Raichur (9.27 ± 1.49 kg/acre).

The highest pH value (7.40 ± 0.22) was reported in Bangalore rural and lowest pH value was 6.95 ± 0.18. The highest and lowest level of EC was reported in Bijapur (0.32 ± 0.03 mmhos/cm) in Hubli and Bangalore rural (0.18 ± 0.02), respectively. The highest and lowest SOC levels were found respectively in Chikkaballapura (0.41 ± 0.04 %) and Hubli (0.29 ± 0.02%).

During the field survey, the percentage disease incidence (DI) was observed to be high in Thumkur district (9 %) followed by Hassan and Mysore districts (7 %). Less than 5 % disease incidence is not considered as severe and it was reported in Chamarajanagara. In this district, moderate to high electrical conductivity was noted. Pathogen isolates from infected kernels and leaves of maize are shown in Fig. 1. Both stalk rot and ear rot were caused predominantly by *Fusarium* spp.

Relation between all nutritional level in soil samples with the percentage disease incidence is presented in Fig. 2. The standard medium range of nitrogen is 280-560 kg/ha, for P is 10-25 kg/ha and for K it is 118-280 kg/ha (NIC-AGRI, 2019) but in the present investigation, in Tumkur, the potassium nutrient level is low compared to normal range, hence the disease incidence was high. The correlation between nutrient levels (NPK) is very important to control the disease by providing resistance attribute in plants. Some other factors (environmental) can also be considered responsible for the causes of disease, but the nutrient level is a most important. Mineral nutrients are important for the growth and development of plants and microorganisms and are important factors in plant–disease interactions (Timothy and Arnold, 2009). Disease triangle is the central dogma of plant pathology. It demonstrates how disease is caused in plants with the interaction of host, environment and pathogens. Interactions between plants, nutrients (environment) and disease causing pathogens are very complex and not completely understood. The disease can be controlled not only by applying chemicals but by also employing nutrition

Table 1. Sample collection sites and their corresponding nutrient and disease incidence levels.

Site	Nitrogen (kg/acre)	Phosphorous (kg/acre)	Potassium (kg/acre)	pH	EC (mmhos/cm)	SOC (%)	Percentage Disease Incidence (%)
Chamarajanagar	89.6 ± 1.5	0.51 ± 0.06	25.55 ± 4.30	7.24 ± 0.23	0.32 ± 0.02	0.33 ± 0.02	05
Mysore	90.0± 2.2	0.39 ± 0.05	30.48 ± 3.68	6.95 ± 0.18	0.27 ± 0.02	0.32 ± 0.02	07
Tumkur	95.3 ± 1.6	0.63 ± 0.07	12.77 ± 2.40	7.20 ± 0.18	0.23 ± 0.01	0.35 ± 0.03	09
Chitradurga	99.0 ± 2.0	0.51 ± 0.06	23.11 ± 1.35	7.04 ± 0.20	0.20 ± 0.01	0.32 ± 0.02	02
Bellary	104.4 ± 2.3	0.98 ± 0.17	21.87 ± 2.25	7.10 ± 0.16	0.25 ± 0.03	0.39 ± 0.05	01
Bijapur,	103.9 ± 1.4	0.69 ± 0.05	10.05 ± 2.24	7.37 ± 0.23	0.32 ± 0.03	0.36 ± 0.04	02
Koppal	102.3 ± 1.0	0.58 ± 0.05	16.56 ± 2.54	7.09 ± 0.17	0.25 ± 0.03	0.34 ± 0.03	02
Gadag	102.1 ± 1.7	0.36 ± 0.05	22.29 ± 2.15	7.15 ± 0.15	0.21 ± 0.07	0.31 ± 0.02	02
Hubli	103.1 ± 1.3	0.54 ± 0.04	13.62 ± 2.30	7.26 ± 0.26	0.18 ± 0.02	0.29 ± 0.02	02
Shimoga,	103.7 ± 1.4	0.73 ± 0.04	20.75 ± 2.96	7.09 ± 0.15	0.30 ± 0.02	0.40 ± 0.02	01
Hassan	103.6 ± 1.3	0.38 ± 0.04	18.67 ± 4.95	7.03 ± 0.17	0.26 ± 0.02	0.32 ± 0.03	07
Gulgarga	103.6 ±0.8	0.53 ± 0.03	21.82 ± 2.35	7.19 ± 0.21	0.30 ± 0.02	0.34 ± 0.02	03
Bidar	106.7 ± 1.4	0.33 ± 0.03	28.07 ± 1.75	7.20 ± 0.15	0.30 ± 0.01	0.40 ± 0.01	04
Raichur	106.1 ± 2.4	1.06 ± 0.10	9.27 ± 1.49	7.04 ± 0.15	0.21 ± 0.02	0.32 ± 0.02	1.5
Chikkaballapura	107.5 ± 1.2	0.57 ± 0.05	32.45 ± 2.57	7.33 ± 0.20	0.29 ± 0.01	0.41 ± 0.04	1.5
Bangalore Rural	98.7 ± 1.2	0.52 ± 0.06	25.00 ± 2.59	7.40 ± 0.22	0.18 ± 0.02	0.31 ± 0.04	02

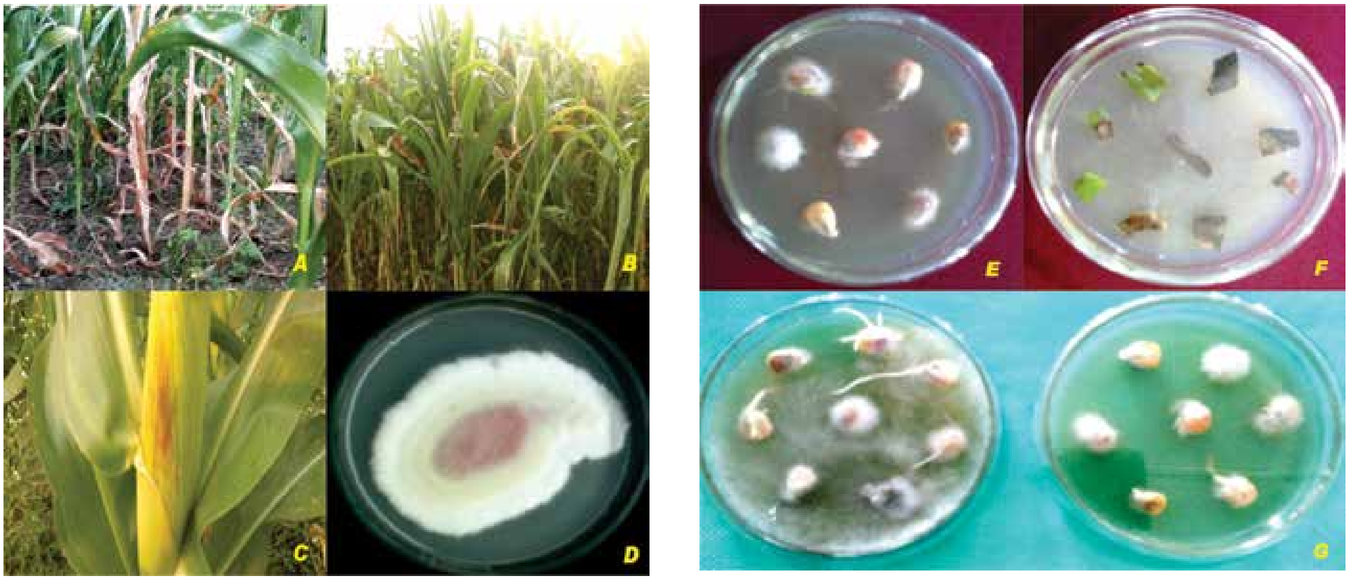

Fig. 1. Field visit photographs showing disease incidence (A, B and C), isolated pathogen (D) and isolation of pathogen (*Fusarium* spp.) from infected kernels and leaves of maize (E, F and G).

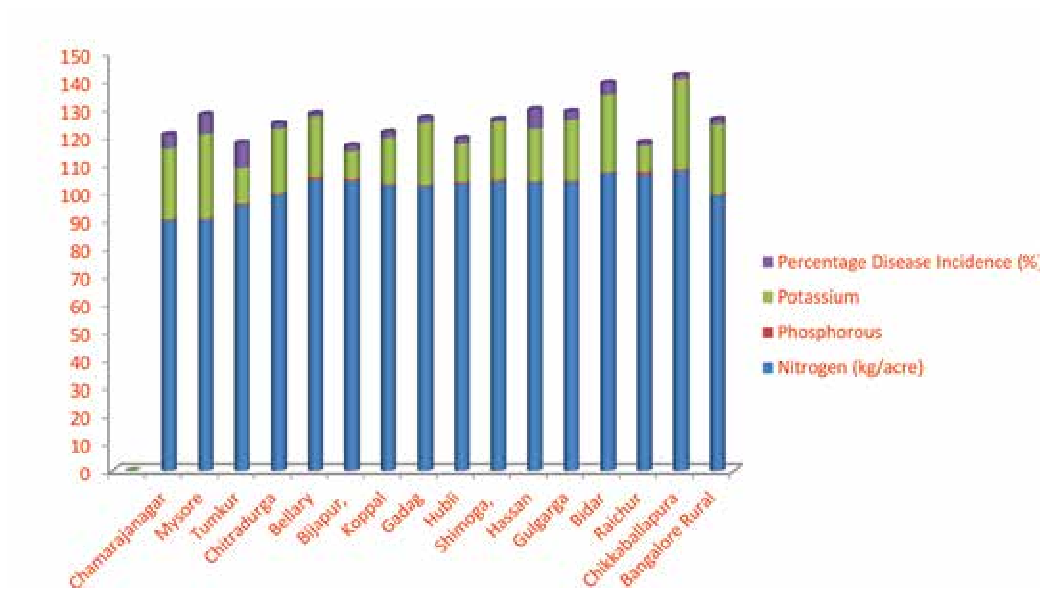

Fig. 2. Dependence between soil fertility status and the percentage disease incidence

as a primary component of disease control strategy. Most cultivated soils abound in pathogens. All nutrients affect plant disease either directly or indirectly. Nutrients and other mineral elements can have a significant impact on all aspects of the disease cycle. Maintaining appropriate nutrient levels allows for proper growth and development. Adequate nitrogen prevents tissue cannibalization. Relationship of P with disease is inconsistent. Increased plant vigor with adequate phosphorous helps increase plant defense mechanisms.

Table 2. Results of correlation analysis between available soil nutrients and percentage of disease incidence.

Name of the nutrients	P- value
Nitrogen	-0.59
Phosphorous	-0.42
Potassium	0.04

Authors' contribution

Conceptualization of research work and designing of experiments (MPG); Execution of field/lab experiments and data collection (MPG); Analysis of data and interpretation (ALV); Preparation of manuscript (ALV)

LITERATURE CITED

Brady N C and Weil R 2008. *The Nature and Properties of Soils* 14th ed. Pearson Education Inc.

Curl E A and Truelove B 1986. *The Rhizosphere*, Springer – Verlag, New York, 228p.

Huber D M and Haneklaus S 2007. Managing nutrition to control plant disease. *Landbauforschung Volkenrode,* **4:** 313 – 22.

Louis E A 2010. Physicochemical characteristics of the rhizosphere soils of some cereal crops in Ambo Woreda, West Shoa, Ethiopia*. Maejo Int J Sci Technol* **4**: 93 – 100.

Marschner H 1995. *Mineral nutrition in plants* 2nd edition, Academic Press London, 889p.

Mishra A, Ghosh S, Dev S, Pandey M. 2015. Maize rhizosphere microbial population in soils of Jharkhand. *Int J Phar Sci* **7**:218 – 22.

NIC-AGRI, 2019. http://raitamitra.kar.nic.in/agriprofile/fertility.htm (Extracted on 25/04/2019)

Patil S, Basavaraju PK, Ramakrishna Parama VR, Chikkaramappa T and Sheshadri T 2007. Effect of different sources and levels of 'K' on maize (*Zea mays* L.) yield, nutrient content and uptake by Maize crop in low 'K' soils of Eastern Dry Zone of Karnataka, India. *Int J Curr Microbiol Appl Sci* **6**: 577 – 87.

Robert M and Berthelin J 1986. Role of biological and biochemical factors in soil mineral weathering; In *Interactions of soil minerals with natural organics and microbes.* Huang P M and Schnitzer M (Eds.).Soil Sci. Soc. Amer. Special publication No 17, Madison, Wisconsin, USA pp. 453 – 95.

Timothy MS and Arnold WS 2009. The Role of Plant Nutrients in Disease Development with Emphasis on Citrus and Huanglongbing. *Proc Fla State Hort Soc* **122**: 169–171.