

Original Research Article

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Relationship between Macro and Micronutrients Profile with Fungal Flora of Rhizosphere Soils from Wheat, Maize and Sorghum Fields of Baramati Area

Rohit Taware, Pooja Kadam, Anuja Shende, Anuradha Bhosale,
M. B. Kanade* and S. J. Chavan

Department of Botany, Tuljaram Chaturchand College of Arts, Science and Commerce,
Baramati (Autonomous), Dist. Pune, Maharashtra, India

*Corresponding author

ABSTRACT

The present study emphasizes on profile of macro and micronutrients and fungal flora of wheat, maize and *Sorghum* rhizosphere soils at sowing, flowering and harvesting stages of crops from Baramati area of Pune district of Maharashtra. From the studied fields total 14 fungal genera and 17 species belonging to fungal group Mastigomycotina (03), Zygomycotina (02), Ascomycotina (01), Basidiomycotina (01) and Deuteromycotina (07) were reported. The wheat field soils of Sangavi, Pandare and Tawadi area showed deficiency of nitrogen and phosphorus, very high amount of potassium and calcium, sufficient amount of magnesium, sulphur at lowest amount, the micronutrients iron, manganese, zinc and copper reported at stress amount compared to standard values. The fungi isolated from wheat fields were majority saprophytic and *Alternaria* and *Fusarium* reported as pathogenic. Macro and micronutrients profile of maize was studied from Deulgaon Rasal, Sangavi and Nimbodi fields. Like wheat fields, maize field soils also showed deficiency values of nitrogen, phosphorous and sulphur. The amount of potassium, calcium and magnesium was very high, the concentration of iron, manganese, zinc and copper were extremely less compared with standard values. The parasitic fungi *Phytophthora*, *Helminthosporium*, *Fusarium* and *Alternaria* were most frequently reported from all studied maize fields. The *Sorghum* field soils studied from Malad, Deulgaon Rasal and Jalgaon reported the deficiency level of nitrogen and phosphorous, the quantity of potassium was at very high level, the amount of calcium and magnesium was adequate and the concentration of sulphur, iron, manganese, zinc and copper were at declined level. Almost saprophytic fungi *Penicillium*, *Aspergillus* and *Mucor* and pathogenic fungi *Helminthosporium* and *Fusarium* were reported frequently from rhizosphere soils of *Sorghum*.

Keywords

Wheat, Maize,
Sorghum, Soil
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Introduction

A healthy soil is an ecosystem teeming with various microbes that perform various vital

functions including deterioration and decomposition of organic matter (Doran, 2002) which helps in soil nutrient enrichment. The fungal flora is one of the important and

most successful inhabitants of soil (Sun *et al.*, 2005) they have ability to product a wide variety of extracellular enzymes and convert dead and organic matter into biomass, carbon dioxide and other macro and micronutrients. The fungal populations are strongly influenced by diversity of the plants community and in return affect plant growth through mutualism, pathogenicity and their affect on nutrient availability and cycling (Wagg *et al.*, 2014). Some pathogenic fungi can disturb the nutrients cycle of soil (Frac *et al.*, 2018), while few can cause economic losses of crops. From the available literature it is confirmed that there should be interrelationship between macro and micronutrients profile available in the soil with the fungal flora inhabitants in the soil. In this connection, the present investigation particularly focusing on the relationship between fungal flora available in the soil with soil nutrients profile of wheat, maize and *Sorghum* fields.

Materials and Methods

The prime objective of present work is to study the interaction of soil fungal flora and macro and micronutrients profile of the soil with respect to common cereal crops *viz.* wheat, maize and *Sorghum* cultivated in Baramati area of Pune district of Maharashtra. In this connection we have collected soil samples from different localities at different stages of the crop plants like sowing, flowering and harvesting stages. The soil samples were collected during the October, 2019 to February, 2020. Particularly rhizosphere soil samples were collected in sterile polythene bags from respective crop fields and brought to laboratory. The soils were clean to remove stones, gravels and other coarse residues, large pieces of soil were broken by hand. The air dried soil samples were crushed in mortal and pestle and sieved through 2mm sieve. These soil

samples were used further for study of soil fungal flora and macro and micronutrient profile of soil. The macro and micronutrients were analysed from Krishi Vidnyan Kendra, Baramati (KVK). Soil fungi were isolated by using serial dilution method (Aneja, 2003). The Czapek's Dox Agar [CDA] (Kanade *et al.*, 2018) and Potato Dextrose Agar [PDA] (Shitole *et al.*, 2019) media supplemented by Penicillin antibiotic.

Inoculated plates were kept for incubation at room temperature for 7 days. At the time of incubation fungal growth was observed regularly and observations were noticed. After 7days of incubation the photographs of plates were taken. Isolated fungal colonies were used for preparation of slides. Slides were prepared using cotton blue stain and lactophenol as mounting medium. Slides were observed under light microscope and microphotography was also done. Fungi were identified on the basis of morphological characters of spores by using standard literature (Nagamani *et al.*, 2006).

Results and Discussion

The present study was carried out to study the profile of inorganic constituents and soil mycoflora of wheat, maize and *Sorghum* rhizosphere soils from Baramati area of Pune district of Maharashtra. In connection with this, total 14 fungal genera and 17 species belonging to fungal group Mastigomycotina (03), Zygomycotina (02), Ascomycotina (01), Basidiomycotina (01) and Deuteromycotina (07) were recorded (Table 1). The percentage contributions of isolated fungal members were noticed as *Mucor*, *Aspergillus* and *Fusarium* (100%), *Rhizopus* (88.88%), *Phytophthora*, *Alternaria* and *Penicillium* (55.55%), *Helminthosporium* (44.44%), *Cryptococcus* (33.33%), *Pythium* and *Trichoderma* (22.22%) and *Achlya*, *Cladosporium* and *Rhizoctonia* (11.11%). It is

investigating to note that, the fungi *Mucor*, *Aspergillus* and *Fusarium* were reported from rhizosphere soils of all crops plants concerning with all the stages of crop plants viz. sowing, flowering and harvesting, on the contrary fungus *Achlya* was reported from the maize fields and *Cladosporium* and *Rhizoctonia* were reported from wheat crop soil samples only (Table 1).

The macro and micronutrients amount was assessed from the rhizosphere soil of wheat, maize and *Sorghum* crop fields at sowing, flowering and harvesting stages of the respective crops depicted in Table 2, 3 and 4. In case of macronutrients, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S) were studied. On the other hand micronutrients iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) were analyzed.

In wheat field soils of Sangavi, Pandare and Tawadi area showed deficiency of nitrogen and phosphorus (Table 2). In Baramati area the level of sufficient amount of nitrogen is 561-700kg/ha, but from collected soil samples maximum amount of nitrogen was reported as

112kg/ha, which was very low compared to standard values. The amount of potassium was very high in all collected soil samples compared to standard profile (251- 300kg/ha) and more amount of potassium was noted from Sangavi soil i.e. 1589kg/ha at sowing stage of wheat. In case of calcium it was also very high in amount like potassium. The adequate amount of calcium in our area is 11+kg/ha, but we recorded 54.9kg/ha calcium concentration from Pandare soil at flowering stage of wheat. Magnesium content was reported as in sufficient amount i.e. more than 70ppm from all the crop plants fields. On the contrary sulphur was reported as less than lowest amount i.e. 6-10ppm from all studied crop fields (Table 2). The profile of micronutrients viz. iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) was very low compared to standard values (i.e. more than 10ppm, 05ppm, 1ppm and 0.4ppm respectively). Maximum amount of iron (0.73ppm), manganese (0.29ppm), Zinc (0.11ppm) and copper (0.15ppm) were recorded from Pandare fields at sowing stage of wheat, but these values are very less compared to standard values (Table 2).

Table.1 List of fungi isolated from wheat, maize and *Sorghum* fields using CDA and PDA media

Sr.No.	Name of fungi	Wheat fields			Maize fields			Sorghum fields		
		S	P	T	D	S	N	M	D	J
1.	<i>Pythium</i> sp.	-	+	+	-	-	-	-	-	-
2.	<i>Phytophthora</i> sp.	-	-	-	+	-	+	+	+	+
3.	<i>Achlya</i> sp.	-	-	-	-	+	-	-	-	-
4.	<i>Rhizopus</i> sp.	+	+	+	+	+	+	+	-	+
5.	<i>Mucor</i> sp.	+	+	+	+	+	+	+	+	+
6.	<i>Trichoderma</i> sp.	+	-	-	-	-	+	-	-	-
7.	<i>Cryptococcus</i> sp.	-	-	+	-	-	-	+	+	-
8.	<i>Cladosporium</i> sp.	-	-	+	-	-	-	-	-	-
9.	<i>Alternaria</i> sp.	-	+	-	+	+	-	+	+	-
10.	<i>Aspergillus</i> sp.	+	+	+	+	+	+	+	+	+
11.	<i>Fusarium</i> sp.	+	+	+	+	+	+	+	+	+
12.	<i>Penicillium</i> sp.	+	+	+	+	-	-	+	-	-
13.	<i>Helminthosporium</i> sp.	-	-	+	+	+	-	+	+	-
14.	<i>Rhizoctonia</i> sp.	-	-	+	-	-	-	-	-	-

(S : Sangavi, P : Pandare, T : Tawadi, D : Deulgaon Rasal, N : Nimbodi, M : Malad, J : Jalgaon crop fields, + present, - absent)

Table.2 Profile of macro and micronutrients and isolated fungi from wheat field soils

Area	Soil samples at	Macronutrients						Micronutrients				Fungi
		N*	P*	K*	Ca*	Mg#	S#	Fe#	Mn#	Zn#	Cu#	
Sangavi	Sowing stage	37.63	3.2	1589	32	97	2.9	0.34	0.15	0.06	0.07	<i>Aspergillus</i> sp. <i>Mucor</i> sp.
	Flowering stage	100	3.6	588	32.5	48	5.86	0.43	0.18	0.06	0.08	<i>Trichoderma</i> sp. <i>Fusarium</i> sp. <i>Penicillium</i> sp. <i>Aspergillus</i> sp.
	Harvesting stage	87.88	2.18	485	43.5	80.5	7.81	0.36	0.15	0.06	0.08	<i>Aspergillus</i> sp. <i>Rhizopus</i> sp.
Pandare	Sowing stage	75.26	5.08	980	47.5	82	5.15	0.73	0.29	0.11	0.15	<i>Rhizopus</i> sp. <i>Mucor</i> sp. <i>Alternaria</i> sp. <i>Penicillium</i> sp. <i>Aspergillus</i> sp.
	Flowering stage	50.17	6.19	833	54.9	23.5	5.1	0.52	0.22	0.08	0.09	<i>Fusarium</i> sp. <i>Alternaria</i> sp. <i>Pythium</i> sp. <i>Rhizopus</i> sp.
	Harvesting stage	25.08	4.46	709	39	20.5	3.82	0.5	0.23	0.06	0.1	<i>Aspergillus</i> sp. <i>Rhizopus</i> sp.
Tawadi	Sowing stage	112	3.04	1197	31.5	64.5	4.83	0.51	0.15	0.05	0.14	<i>Aspergillus</i> sp. <i>Rhizopus</i> sp. <i>Fusarium</i> sp.
	Flowering stage	100	2.85	581	32.5	70.5	2.58	0.42	0.16	0.06	0.11	<i>Aspergillus</i> sp. <i>Mucor</i> sp. <i>Penicillium</i> sp. <i>Cladosporium</i> sp. <i>Cryptococcus</i> sp.
	Harvesting stage	87.88	1.23	645	39.	91	5.77	0.44	0.27	0.06	0.13	<i>Rhizoctonia</i> sp. <i>Aspergillus</i> sp. <i>Helminthosporium</i> sp. <i>Pythium</i> sp.

*kilogram/hectare, # parts/million

Table.3 Profile of macro and micronutrients and isolated fungi from maize field soils

Area	Soil samples	Macronutrients						Micronutrients				Fungi
		N*	P*	K*	Ca*	Mg#	S#	Fe#	Mn#	Zn#	Cu#	
Deulgaon Rasal	Sowing stage	87.88	4.69	448	34.5	47.5	0.38	0.53	0.38	0.05	0.26	<i>Aspergillus</i> sp. <i>Mucor</i> sp. <i>Phytophthora</i> sp. <i>Rhizopus</i> sp.
	Flowering stage	37.68	3.6	4655	51.5	75	0.12	0.59	0.12	0.03	0.14	<i>Helminthosporium</i> sp. <i>Fusarium</i> sp. <i>Penicillium</i> sp. <i>Aspergillus</i> sp.
	Harvesting stage	122	3.44	510	34	49.5	0.27	0.47	0.27	0.05	0.23	<i>Phytophthora</i> sp. <i>Alternaria</i> sp. <i>Fusarium</i> sp.
Sangavi	Sowing stage	12.54	5.64	534	40.5	49.5	0.45	0.74	0.45	0.07	0.23	<i>Alternaria</i> sp. <i>Achlya</i> sp. <i>Aspergillus</i> sp.
	Flowering stage	50.17	5.72	561	57	95	0.5	0.49	0.5	0.06	0.31	<i>Helminthosporium</i> sp. <i>Fusarium</i> sp. <i>Mucor</i> sp. <i>Aspergillus</i> sp.
	Harvesting stage	25.08	4.93	523	57.5	77.5	0.17	0.48	0.17	0.01	0.1	<i>Alternaria</i> sp. <i>Rhizopus</i> sp. <i>Mucor</i> sp.
Nimbodi	Sowing stage	12.54	3.75	323	39.5	46.5	0.46	0.49	0.46	0.21	0.21	<i>Rhizopus</i> sp. <i>Fusarium</i> sp. <i>Trichoderma</i> sp.
	Flowering stage	87.88	2.33	377	31.5	46.5	0.1	0.61	0.1	0.03	0.13	<i>Aspergillus</i> sp. <i>Mucor</i> sp. <i>Trichoderma</i> sp.
	Harvesting stage	112	2.96	382	31	50	0.22	0.32	0.22	0.03	0.03	<i>Mucor</i> sp. <i>Phytophthora</i> sp. <i>Aspergillus</i> sp.

*kilogram/hectare, # parts/million

Table.4 Profile of macro and micronutrients and isolated fungi from *Sorghum* field soils

Area	Soil samples at	Macronutrients						Micronutrients				Fungi
		N*	P*	K*	Ca*	Mg#	S#	Fe#	Mn#	Zn#	Cu#	
Malad	Sowing stage	37.63	2.65	10.26	26	63.5	2.58	0.43	0.05	0.06	0.04	<i>Aspergillus</i> sp. <i>Mucor</i> sp. <i>Rhizopus</i> sp.
	Flowering stage	100	2.25	1360	39.5	51.5	3.18	0.55	0.15	0.06	0.07	<i>Helminthosporium</i> sp. <i>Penicillium</i> sp. <i>Fusarium</i> sp. <i>Aspergillus</i> sp.
	Harvesting stage	87.88	0.52	12.88	36.5	63	4.12	0.7	0.27	0.07	0.1	<i>Fusarium</i> sp. <i>Trichoderma</i> sp. <i>Aspergillus</i> sp.
Deulgaon Rasal	Sowing stage	37.63	1.39	593	48	51.5	5.86	0.3	0.9	0.05	0.06	<i>Trichoderma</i> sp. <i>Rhizopus</i> sp. <i>Mucor</i> sp. <i>Aspergillus</i> sp.
	Flowering stage	12.54	1.23	542	50.5	60	3.18	1.7	0.1	0.06	0.03	<i>Helminthosporium</i> sp. <i>Mucor</i> sp. <i>Fusarium</i> sp. <i>Trichoderma</i> sp.
	Harvesting stage	112	0.84	650	45	30	2.6	0.32	0.68	0.04	0.05	<i>Fusarium</i> sp. <i>Aspergillus</i> sp. <i>Mucor</i> sp.
Jalgaon	Sowing stage	87.88	3.36	534	63.5	132.5	1.82	0.39	0.27	0.06	0.08	<i>Rhizopus</i> sp. <i>Mucor</i> sp. <i>Penicillium</i> sp. <i>Fusarium</i> sp.
	Flowering stage	75.26	1	18.41	31	80	3.18	0.44	0.89	0.06	0.08	<i>Aspergillus</i> sp. <i>Mucor</i> sp.
	Harvesting stage	50.17	8.31	19.70	39.5	42.5	4.42	0.5	1.89	0.19	0.17	<i>Mucor</i> sp. <i>Penicillium</i> sp. <i>Aspergillus</i> sp. <i>Trichoderma</i> sp.

*kilogram/hectare, # parts/million

The fungi isolated from wheat fields were majority saprophytic, on the hands *Alternaria* and *Fusarium* reported as pathogenic from Pandare and Tawadi fields at flowering and sowing stages of wheat respectively.

Macro and micronutrient profile of maize was studied from Deulgaon Rasal, Sangavi and Nimbodi fields. The macro and micronutrients profile of studied maize fields was majority near about same. Like wheat fields, maize fields also showed deficiency values of nitrogen, phosphorous and sulphur.

The amount of potassium (4655kg/ha), calcium (57.5kg/ha) and magnesium (95ppm) was very high compared to standard concentrations (i.e. 251-300kg/ha, >11kg/ha and >70ppm respectively). In case of micronutrients, the values of iron (0.74ppm), manganese (0.46ppm), zinc (0.21ppm) and copper (0.31) were remarkably less compared with standard profile (i.e. >10ppm, >5pm, >1ppm and >0.4ppm respectively) (Table 3).

The fungi reported from maize fields were majority parasitic. *Phytophthora*,

Helminthosporium, *Fusarium* and *Alternaria* species were most frequently occurred from all studied maize fields at all crop stages i.e. sowing, flowering and harvesting (Table 3).

In case of *Sorghum* fields the study areas were Malad, Deulgaon Rasal and Jalgaon. The values of nitrogen and phosphorous showed very less in quantity i.e. near about deficiency level from all the studied areas. Potassium content also showed drastic changes in its quantity. The amount of potassium was sufficient from Deulgaon Rasal *Sorghum* fields at sowing, flowering and harvesting stages, on the contrary from Malad fields it was high at flowering stages and from Jalgaon fields high at sowing stages. The concentration of calcium and magnesium was adequate amount from all the studied areas at all *Sorghum* stages (Table 4). The concentration of sulphur, iron, manganese, zinc and copper were again declined at *Sorghum* fields of all studied areas at all stages of crop plants (sowing, flowering and harvesting).

The isolated fungi from the *Sorghum* fields were almost saprophytic like *Penicillium*, *Aspergillus*, *Mucor* etc. and pathogenic fungi *Helminthosporium* and *Fusarium* were reported frequently from all fields of *Sorghum* (Table 4).

A soil is the key foundation of crops in agricultural fields where the fungal flora plays vital role in its nutrient profile. In droughts the fungi protects plant root by protective sheath to supply both water and phosphorous (Magdoff and Harold, 2009). According to Muhammad *et al.*, (2016) microbes, bacteria and fungi naturally occurring in soil or supplied as bio-fertilizers, could represent a promising approach to increase nutrients bioavailability and improve soil structure. Anil Kumar *et al.*, (2016) stated that, availability of micronutrients to plants is

regulated by various soil factors including such as texture, soil reaction, organic matter, clay content, soil moisture, nutrient interactions in soil, microbial activity, redox potential and aeration. Moreover, they noticed that, exploitation of soil microbes such as micronutrient solubilisers and AM fungi has proven as boon in micronutrient uptake and improving soil quality. Naheeda *et al.*, (2019) concluded that, arbuscular mycorrhizal fungi (AMF) being natural root symbionts, provide essential plant inorganic nutrients to host plants, thereby improving growth and yield under unstressed and stressed regimes. Furthermore they described that, improved resistance to a variety of stresses including drought, salinity, herbivory, temperature, metals, and diseases due to fungal symbiosis.

It is vividly clear from the present results that, the concentration of nitrogen and phosphorous is very low or at deficiency level from all the crop plants at their sowing, flowering and harvesting stages. Level of potassium, calcium and magnesium is sufficient in amount from soils of all studied crop plants. On the contrary profile of sulphur, iron, manganese, zinc and copper showed tremendous inhibitory trend or at deficiency level from wheat, maize and *Sorghum* fields at all the crop plant stages studied. The macro and microelements of soil plays an important role in healthy and better growth of the crops (Agrios, 2005 and Datnoff *et al.*, 2007), but farmers should not bother about this. Hence before sowing the crop seeds, agriculture soil should be tested from the soil testing laboratories (Bhatt and Sharma, 2011).

The role of soil fungi in healthy growth of crop plants is proven by many workers (Bagyaraj and Ashwin, 2017). They play an important role in deteriorating and decomposition of soil organic matter, maintain soil humans conditions and

biocontrolling of plant pathogenic fungi (Zifcakova *et al.*, 2016; Treseder and Lennon, 2015). There is strong relationship between amount of macro and micronutrients with population and multiplication of soil mycoflora (Richard *et al.*, 2017). Many saprophytic fungi directly or indirectly are helpful in healthy crop growth (Arriagada *et al.*, 2009a,b). So, farmers should take care of the health of their agriculture soils, avoid unknowingly and indiscriminate use of chemical fertilizers.

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