

Original Research Article

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Effect of Site Specific Nutrient Management in Potato based Sequential Cropping Systems on Microbial Population Dynamics

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ABSTRACT

A field experiments were conducted on the “Effect of site specific nutrient management in potato based sequential cropping systems on microbial population dynamics” in the premises of Agricultural Research Station (ARS), Madenur, Hassan Taluk and District during *Kharif* and *Rabi* 2017 and 2018. Experiment consisting of twelve treatments (T₁: 100 % K through KCl + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₂: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₃: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₄: 50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₅: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₆: 100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₇: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₈: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₉: 50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₁₀: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₁₁: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹), T₁₂: Package of Practice recommendation, UAS, B) and replicated thrice. Among the soil biological properties, microbial activity *viz.*, bacteria, fungi and actinomycetes count after harvest of potato was significantly higher in treatments receiving 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (10.27 x 10⁶ Cf_u g⁻¹, 6.25 x 10⁴ Cf_u g⁻¹ and 4.02 x 10² Cf_u g⁻¹, respectively) across all the treatments.

Keywords

Cropping system,
Microbial
properties, Potato,
SSNM

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Introduction

Among several factors deciding the crop productivity over a specific time and area, nutrients supply plays a key role after water. The nutrient required by the crop either in larger or smaller quantities decides the

productivity by its role in plant metabolic activities. The current and generalized fertilizer recommendations which were developed decades ago are losing their applicability due to the variability of soil fertility both in spatial and temporal dimensions. In addition to this, high crop

removal coupled with less addition of nutrients by farmers has resulted in large scale depletion of macro and micro nutrients in the cultivated soil leading to emergence of deficiency in soil and crops, thus causing a shift in fertility from high to medium or medium to low nutrient status over the years. Further, the crop requirement for various nutrients vary greatly among fields, years and seasons as a result of variations in climate, crop growing conditions and also due to differences in crop and soil management practices. Thus, the current and generalized fertilizer recommendations which were developed decades ago were no longer valid and there is a need for finding a novel approach of nutrient management which takes into account of both field and crop specific requirements of nutrients.

Recent advances in nutrient management research have come out with an advanced technique of supplying nutrient to crop according to variability in soil over space and requirement during a particular growth period. The approach is termed as 'site specific nutrient management (SSNM). The novel approach of SSNM involves science-based principles for guiding the judicious and efficient application of fertilisers as and when needed by crops. It recognizes the inherent spatial variability associated with soil during crop production and provides guidelines for optimal use of indigenous nutrients originating from soil, plant residues, manures and irrigation water. Thus, SSNM considers indigenous nutrient supply of the soil and productivity and targets the capability of sustaining higher yields on one hand, and assured restoration of soil fertility on the other.

Cropping system is generally practiced on small farms with limited resources and it has been observed to enhance yields with greater stability in a variety of crop combinations.

Moreover, these systems is known by less use of inputs, namely, fertilizers, plant protection chemical and thus healthy, safe and high quality food under ecologically sound production system. On-farm biodiversity is also promoted by diversification of crops through crop rotation and intercropping systems resulting in variation of diet and more net return, higher level of production stability, proper utilization of limited resources human labour-force under low levels of technological intervention and all these ultimately lead to achieve production sustainability in agriculture. At present in Hassan district, potato-finger millet or potato-maize cropping sequence is gaining importance as dominant cropping systems. Since both potato and maize are exhaustive crops, maintaining both crop and soil productivity is one of the crucial factor for attaining higher yield.

Today, roots and tubers are the third largest carbohydrate food source in the world, with potatoes representing nearly half of all root crops consumed (Anon., 2018). Potatoes contribute key nutrients to the diet including vitamin C, potassium, and dietary fibre (McGill *et al.*, 2013). In fact, potatoes have a more favourable overall nutrient-to-price ratio than many other vegetables and are an important staple worldwide (Drewnowski, 2013). Even though the crop is known for its hardiness, its productivity under large scale production is decided by water and nutrient management techniques followed. Numerous studies document the crop response to N, P, and K fertilizer application. Yield and tuber quality are affected by both excess and lower application of nutrients. While, the negative impacts of over application of nutrients are attributed to salt damage (Bilski *et al.*, 1988), disease (Somani and Shekhawat, 1988) and physiological changes (Westermann *et al.*, 1994), lower availability of nutrients alter the crop productivity by influencing crop water relationships, variability of transpiration rates

and increments in plant body temperature (Yli-Halla *et al.*, 1987). Hence, keeping in view of the importance of nutrient management and its role in crop productivity, experiments were conducted to study the effect of site specific nutrient management in potato based sequential cropping systems on microbial population dynamics.

Materials and Methods

Field experiments were conducted on the “Effect of site specific nutrient management in potato based sequential cropping systems on microbial population dynamics” in the premises of Agricultural Research Station (ARS), Madenur, Hassan Taluk and District during *Kharif* and *Rabi* 2017 and 2018. The experimental plots of *kharif* season were divided into two plots to raise finger millet and field bean crops with recommended dose of fertilizers to study the effect of SSNM on succeeding crops. The treatment details consisting of twelve treatments (T₁: 100 % K through KCl + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₂: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₃: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₄: 50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₅: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₆: 100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₇: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₈: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₉: 50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₁₀: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted

yield of 25 t ha⁻¹, T₁₁: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹), T₁₂: Package of Practice recommendation, UAS, B) with three replication. The experimental data obtained were subjected to statistical analysis adopting Fisher’s method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (1984). The level of significance used for F test was 5 per cent. Critical difference (CD) values are given in the table at 5 per cent level of significance, wherever the “F” test was significant at 5 per cent level. Pooled analysis of two years data was analysed using Additive Main Multiplicative Interaction (AMMI) method by Felipe de Mendibur (2020).

Results and Discussion

Significantly higher bacterial population was observed in soil after harvest of potato in plot which received 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (10.27 x 10⁶ Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (10.05 x 10⁶ Cf_u g⁻¹) as compared to other treatments.. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (2.65 x 10⁶ Cf_u g⁻¹) (Table 1). Fungal population was significantly higher with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (6.25 x 10⁴ Cf_u g⁻¹) and it was found to be on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (6.06 x 10⁴ Cf_u g⁻¹), 100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹ (5.92 x 10⁴ Cf_u g⁻¹) and 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹ (5.75 x 10⁴ Cf_u g⁻¹) as compared to other treatments. Significantly lower fungal population was observed in recommended dose of fertilizers alone (2.55 x

10⁴ Cf_u g⁻¹) (Table 1). Significantly higher actinomycetes population was observed in soil after harvest of potato in plot which received 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (4.02 x 10² Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (3.90 x 10² Cf_u g⁻¹) as compared to other treatments. Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (1.85 x 10² Cf_u g⁻¹) (Table 1). Similar findings were also reported by Corne

et al., (2017) and Cui *et al.*, (2018). Significantly higher bacterial population was observed in soil after harvest of finger millet with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (12.40 x 10⁵ Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (12.20 x 10⁵ Cf_u g⁻¹) as compared to other treatments.. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (2.50 x 10⁵ Cf_u g⁻¹) (Table 2).

Table.1 Microbial population in soil after harvest of potato as influenced by site specific nutrient management in potato based sequential cropping system

Treatments	Bacteria (x 10 ⁶ Cf _u g ⁻¹)			Fungi (x 10 ⁴ Cf _u g ⁻¹)			Actinomycetes (x 10 ² Cf _u g ⁻¹)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁	3.50	3.93	3.72	3.10	3.60	3.35	2.10	2.20	2.15
T ₂	3.30	3.50	3.40	3.00	3.52	3.26	2.00	2.12	2.06
T ₃	4.75	5.00	4.88	4.15	4.50	4.33	2.85	2.90	2.88
T ₄	3.90	4.73	4.32	5.00	5.30	5.15	2.10	2.60	2.35
T ₅	4.50	5.90	5.20	4.32	4.70	4.51	2.80	2.91	2.86
T ₆	5.20	6.10	5.65	5.80	6.03	5.92	2.70	2.90	2.80
T ₇	7.52	8.50	8.01	5.50	6.00	5.75	2.90	3.80	3.35
T ₈	9.53	11.00	10.27	6.00	6.50	6.25	3.81	4.23	4.02
T ₉	7.10	8.00	7.55	5.00	5.30	5.15	2.90	2.90	2.90
T ₁₀	9.30	10.80	10.05	5.81	6.30	6.06	3.71	4.10	3.90
T ₁₁	2.60	2.70	2.65	2.30	2.80	2.55	1.80	1.90	1.85
T ₁₂	4.00	4.80	4.40	3.10	3.70	3.40	2.80	2.90	2.85
F-test	**	**	**	**	**	**	**	**	**
S.Em ±	0.20	0.22	0.15	0.27	0.24	0.18	0.20	0.15	0.13
C.D. @ 5%	0.58	0.66	0.43	0.80	0.71	0.52	0.59	0.44	0.36

Legend

T₁:100 % K through KCl + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₂:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₃:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₄:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₅:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₆:100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₇:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₈:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₉:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₀:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₁:Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹)

T₁₂:Package of Practice recommendation (UAS B)

Table.2 Microbial population in soil after harvest of finger millet as influenced by site specific nutrient management in potato based sequential cropping system

Treatments	Bacteria (x 10 ⁵ Cf _u g ⁻¹)			Fungi (x 10 ³ Cf _u g ⁻¹)			Actinomycetes (x 10 ² Cf _u g ⁻¹)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T₁	2.00	3.63	2.82	1.50	2.40	1.95	1.10	1.30	1.20
T₂	3.80	4.00	3.90	2.00	2.50	2.25	1.20	1.40	1.30
T₃	5.23	5.50	5.37	2.97	3.27	3.12	1.30	1.54	1.42
T₄	5.20	5.23	5.22	1.60	2.37	1.99	1.22	1.40	1.31
T₅	5.00	6.40	5.70	4.10	4.70	4.40	1.20	1.80	1.50
T₆	5.72	6.60	6.16	4.00	5.00	4.50	1.50	2.03	1.77
T₇	8.00	9.00	8.50	5.20	5.90	5.55	2.00	2.40	2.20
T₈	12.00	12.80	12.40	5.90	7.10	6.50	2.58	2.85	2.72
T₉	7.62	8.50	8.06	4.40	5.40	4.90	1.80	2.01	1.91
T₁₀	11.80	12.60	12.20	5.80	7.00	6.40	2.50	2.82	2.66
T₁₁	2.10	2.90	2.50	1.50	2.30	1.90	1.00	1.20	1.10
T₁₂	3.50	4.30	3.90	2.20	3.43	2.82	1.20	1.40	1.30
F-test	**	**	**	**	**	**	**	**	**
S.Em ±	0.21	0.27	0.17	0.14	0.18	0.11	0.08	0.11	0.07
C.D. @ 5%	0.62	0.79	0.49	0.42	0.52	0.32	0.23	0.32	0.19

Legend

T₁:100 % K through KCl + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₂:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₃:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₄:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₅:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₆:100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₇:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₈:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₉:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₀:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₁:Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹)

T₁₂:Package of Practice recommendation (UAS B)

Table.3 Microbial population in soil after harvest of field bean as influenced by site specific nutrient management in potato based sequential cropping system

Treatments	Bacteria (x 10 ⁶ Cf _u g ⁻¹)			Fungi (x 10 ⁴ Cf _u g ⁻¹)			Actinomycetes (x 10 ² Cf _u g ⁻¹)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T ₁	6.00	7.63	6.82	4.00	4.87	4.43	3.00	3.30	3.15
T ₂	7.84	8.00	7.92	4.50	5.00	4.75	3.00	3.10	3.05
T ₃	9.20	9.50	9.35	5.47	5.80	5.64	3.90	4.42	4.16
T ₄	6.22	7.23	6.73	4.10	4.87	4.49	2.52	2.91	2.72
T ₅	9.00	10.40	9.70	6.60	7.20	6.90	3.80	3.90	3.85
T ₆	9.72	10.60	10.16	6.50	7.50	7.00	3.72	4.10	3.91
T ₇	12.00	13.00	12.50	7.70	8.40	8.05	4.50	4.80	4.65
T ₈	16.00	16.72	16.36	8.20	10.00	9.10	5.40	5.95	5.68
T ₉	11.73	12.50	12.12	6.90	7.90	7.40	3.81	4.23	4.02
T ₁₀	15.50	16.43	15.97	8.05	9.90	8.98	5.32	5.85	5.58
T ₁₁	6.10	6.90	6.50	4.00	4.80	4.40	2.70	3.00	2.85
T ₁₂	7.50	8.30	7.90	4.72	5.93	5.32	2.90	3.30	3.10
F-test	**	**	**	**	**	**	**	**	**
S.Em ±	0.27	0.12	0.15	0.19	0.26	0.16	0.17	0.22	0.14
C.D. @ 5%	0.80	0.35	0.42	0.28	0.77	0.47	0.48	0.64	0.39

Legend:

T₁:100 % K through KCl + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₂:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹

T₃:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₄:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₅:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹

T₆:100 % K through KCl + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₇:100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹

T₈:100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₉:50 % K through Bio-K + 50 % K through KCl + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₀:50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹

T₁₁:Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹)

T₁₂:Package of Practice recommendation (UAS B)

Fungal population was significantly higher with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (6.50 x 10³ Cf_u g⁻¹) and it was found to be on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (6.40 x 10³ Cf_u g⁻¹) as compared to other treatments.

Significantly lower fungal population was observed in recommended dose of fertilizers alone (1.90 x 10³ Cf_u g⁻¹) (Table 2). Significantly higher actinomycetes population was observed in soil after harvest of finger millet in plot which received 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (2.72 x

10^2 Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (2.66×10^2 Cf_u g⁻¹) as compared to other treatments. Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (1.10×10^2 Cf_u g⁻¹). The higher microbial population might have been possible owing to enhanced supply of available food and energy to these organisms in soil through supply Bio-K. Microbes are known to increase the availability of immobile micronutrients such as Fe, Zn, Cu and Mn along with major nutrient phosphorus through mobilization process. The Improved microbial properties due to improve the metabolic activities of plant, increased in organic matter content of the soil resulting in a significant increase microbial activity. The similar results are in line with the findings of Anand (2010). This could result in better growth of microorganism which in turn resulted in more release of root exudates which acts as a source of carbon and energy for microorganisms.

Significantly higher bacterial population was observed in soil after harvest of field bean in plot which received 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (16.36×10^6 Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (15.97×10^6 Cf_u g⁻¹) as compared to other treatments.. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (6.50×10^6 Cf_u g⁻¹) (Table 3). Fungal population was significantly higher with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (9.10×10^4 Cf_u g⁻¹) and it was found to be on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t

ha⁻¹ (8.98×10^4 Cf_u g⁻¹)^{as} compared to other treatments. Significantly lower fungal population was observed in recommended dose of fertilizers alone (5.32×10^4 Cf_u g⁻¹) (Table 3).

Significantly higher actinomycetes population was observed in soil after harvest of field bean in plot which received 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (5.68×10^2 Cf_u g⁻¹) and it was on par with 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (5.58×10^2 Cf_u g⁻¹) as compared to other treatments. Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (2.85×10^2 Cf_u g⁻¹) (Table 3). The microbial analysis pertaining to bacteria, fungi and actinomycetes population in soil after harvest of field bean differed significantly due to supply of nutrients through site specific nutrient management and Bio-K which improved the organic matter content and nutrient status of soil in potato based sequential cropping system resulted in higher microbial activity (Anand 2010 and Lingaraju, 2018).

In conclusion potato-finger millet and potato-field bean cropping systems, supply of potassium through combination of Bio-K and SOP under SSNM approach are beneficial to increase the microbial population in the above cropping systems.

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