

Original Research Article

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Impact of Potato + Pigeon Pea based Intercropping Systems on Microbial Properties

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ABSTRACT

A field experiments were conducted on the “Impact of potato + pigeon pea based intercropping systems on microbial properties” 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 K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₂: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₃: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₄: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₅: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₆: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₇: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹), T₈: 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 (15.87 x 10⁶ Cf_u g⁻¹, 9.53 x 10⁴ Cf_u g⁻¹ and 5.15 x 10² Cf_u g⁻¹, respectively) 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 (15.15 x 10⁶ Cf_u g⁻¹, 9.23 x 10⁴ Cf_u g⁻¹ and 5.02 x 10² Cf_u g⁻¹, respectively) across all the treatments in potato and finger millet (13.80 x 10⁵ Cf_u g⁻¹, 8.36 x 10³ Cf_u g⁻¹ and 3.06 x 10² Cf_u g⁻¹, respectively) across all the treatments.

Keywords

Intercropping Systems, Potato, Pigeon pea

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Introduction

Differences in crop yield between different fields in the same region have existed for a long time. Methods for improving the

productivity of low-yield fields are a hot topic in large-scale agriculture. Potato plants have shallow root systems and are grown widely in India. In pursuit of higher yields, farmers are applying tremendous amounts of fertilizers,

which have led to not only lower yield, but low nutrient use efficiency and environmental problems as well. For better improvement of nutrient use efficiency and decreased environmental impacts, improved methods for optimum fertilizer recommendations are necessary for potato crop. Low soil fertility and crop nutrient imbalances are two major obstacles preventing farmers from realizing the higher yields. The extensive nutrient depletion, soil degradation and soil quality deterioration are due to ineffective agricultural practices and inefficient fertilizer application.

Potassium, being associated with the movement of water, nutrients and carbohydrates in plant tissues, activation enzymes affecting protein, starch and adenosine triphosphate (ATP) production, thereby acts as a regulator of rate of photosynthesis, required by the crop in larger quantities and therefore called as a macronutrient.

In many annual crops, potassium has roles in regulation of stomata, which regulates the exchange of water vapour, oxygen and carbon dioxide between plant and environment. Indirectly, this stomata regulation is helpful in maintenance of plant temperature, as many of the reactions in the plant organs are temperature dependant, stunted crop growth and yield reduction are noticeable under deficiency and inadequate supply of this nutrient.

Even though the total K content of soils exceeds 20,000 ppm (parts per million) in most of the cultivated soils and its supply from the soil is also quite large, very small amounts are available for plant growth at a particular time since most of the soil potassium is locked in the structural component of soil minerals making it unavailable for plant absorption and utilization for growth. Even though it is supplied by external sources like fertilizers,

non-scientific recommendations and application methodologies affect its availability to crop. Research conducted by International Plant Nutrition Institute (IPNI) in India clearly shows that guidelines for fertiliser potassium recommendations are inadequate for current yield targets, and as a result the soil test K level once considered adequate turns out to be insufficient to balance the high rates of N and P being applied (Tiwari *et al.*, 2005).

So, there is a need to think on advanced approach to make sure that the potassium is applied as and when the crop requires it and applied potassium is efficiently utilized by the crop. As explained above, site specific nutrient management is the most promising approach for succeeding in this direction.

Among the various methods of fertilizer application approaches, the one based on “yield targeting” (SSNM) are unique in the sense that these methods not only indicates soil test based fertilizer dose but also the level of yield the farmer can hope to achieve if good nutrient management practices are followed in raising the crop. Therefore, considering the importance of the aspects experiments were conducted to study the impact of potato + pigeon pea based intercropping systems on microbial properties.

Materials and Methods

Field experiments were conducted on the “Impact of potato + pigeon pea based intercropping systems on microbial properties” 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 K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹, T₂: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₃: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹, T₄: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹, T₅: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₆: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹, T₇: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹), T₈:

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

The microbial analysis pertaining to bacteria, fungi and actinomycetes population in soil after harvest of potato differed significantly due to supply of nutrients through site specific nutrient management in potato + pigeon pea based inter cropping system and are presented in Table 1. 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 (15.87 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 (15.15 x 10⁶ Cf_u g⁻¹) as compared to other treatments.. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (6.18 x 10⁶ Cf_u g⁻¹).

Fungal population was significantly higher with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (9.53 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 (9.23 x 10⁴ Cf_u g⁻¹) as compared to other treatments.

Significantly lower fungal population was observed in recommended dose of fertilizers alone (4.25 x 10⁴ Cf_u g⁻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 (5.15 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 (5.02 x 10² Cf_u g⁻¹) as compared to other treatments.

Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (2.66 x 10² Cf_u g⁻¹) (Table 1). Similar results were given by Nyawade *et al.*, (2019) in potato crop.

The bacteria, fungi and actinomycetes population in soil after harvest of finger millet due to site specific nutrient management in potato + pigeon pea based inter cropping system are presented in Table 2.

Table.1 Microbial population in soil after harvest of potato as influenced by site specific nutrient management in potato + pigeon pea based intercropping 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 | 7.02 | 7.60 | 7.31 | 4.00 | 4.50 | 4.25 | 3.50 | 4.20 | 3.85 |
| T ₂ | 8.01 | 9.00 | 8.51 | 6.13 | 6.81 | 6.47 | 3.90 | 4.50 | 4.20 |
| T ₃ | 9.03 | 10.10 | 9.57 | 6.00 | 6.60 | 6.30 | 4.02 | 4.51 | 4.27 |
| T ₄ | 11.00 | 11.71 | 11.36 | 7.50 | 8.11 | 7.81 | 4.00 | 4.50 | 4.25 |
| T ₅ | 15.50 | 16.23 | 15.87 | 9.03 | 10.02 | 9.53 | 4.59 | 5.70 | 5.15 |
| T ₆ | 14.50 | 15.80 | 15.15 | 8.75 | 9.70 | 9.23 | 4.50 | 5.54 | 5.02 |
| T ₇ | 6.03 | 6.33 | 6.18 | 4.10 | 4.40 | 4.25 | 2.62 | 2.70 | 2.66 |
| T ₈ | 6.50 | 7.00 | 6.75 | 4.30 | 4.60 | 4.45 | 3.72 | 4.32 | 4.02 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.37 | 0.40 | 0.27 | 0.30 | 0.32 | 0.22 | 0.23 | 0.26 | 0.17 |
| C.D.@ 5 % | 0.11 | 1.20 | 0.78 | 0.90 | 0.45 | 0.63 | 0.70 | 0.80 | 0.51 |

Legend:

| | |
|--|--|
| T ₁ : 100 % K through K ₂ SO ₄ + NP through fertilizers for targeted yield of 20 t ha ⁻¹ | T ₅ : 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha ⁻¹ |
| T ₂ : 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha ⁻¹ | T ₆ : 50 % K through Bio-K + 50 % K through K ₂ SO ₄ + balance NP through fertilizers for targeted yield of 25 t ha ⁻¹ |
| T ₃ : 50 % K through Bio-K + 50 % K through K ₂ SO ₄ + balance NP through fertilizers for targeted yield of 20 t ha ⁻¹ | T ₇ : Recommended dose of fertilizers alone (75:75:100 kg NPK ha ⁻¹) |
| T ₄ : 100 % K through K ₂ SO ₄ + NP through fertilizers for targeted yield of 25 t ha ⁻¹ | T ₈ : 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 + pigeon pea based intercropping cropping system

| Treatments | Bacteria (x 10 ⁵ Cfu g ⁻¹) | | | Fungi (x 10 ³ Cfu g ⁻¹) | | | Actinomycetes (x 10 ² Cfu g ⁻¹) | | |
|------------------|---|-------------|-------------|--|-------------|-------------|--|-------------|-------------|
| | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled |
| T ₁ | 5.27 | 5.70 | 5.48 | 3.50 | 3.60 | 3.55 | 1.30 | 1.40 | 1.35 |
| T ₂ | 7.70 | 8.52 | 8.11 | 3.02 | 3.30 | 3.16 | 2.80 | 2.73 | 2.77 |
| T ₃ | 8.22 | 8.64 | 8.43 | 5.00 | 5.43 | 5.22 | 2.43 | 2.52 | 2.48 |
| T ₄ | 9.20 | 9.70 | 9.45 | 6.51 | 6.80 | 6.66 | 2.04 | 2.30 | 2.17 |
| T ₅ | 13.20 | 14.40 | 13.80 | 8.01 | 8.70 | 8.36 | 3.00 | 3.12 | 3.06 |
| T ₆ | 12.80 | 13.80 | 13.30 | 7.20 | 8.22 | 7.71 | 2.80 | 3.07 | 2.93 |
| T ₇ | 4.24 | 4.80 | 4.52 | 2.30 | 2.80 | 2.55 | 1.10 | 1.30 | 1.20 |
| T ₈ | 4.60 | 4.90 | 4.75 | 2.50 | 3.00 | 2.75 | 1.50 | 1.70 | 1.60 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.41 | 0.50 | 0.32 | 0.31 | 0.25 | 0.20 | 0.18 | 0.16 | 0.12 |
| C.D.@ 5 % | 1.25 | 1.51 | 0.94 | 0.93 | 0.76 | 0.57 | 0.53 | 0.48 | 0.34 |

Legend:

| | |
|---|---|
| T₁: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₅: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ |
| T₂: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₆: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ |
| T₃: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₇: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹) |
| T₄: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹ | T₈: 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 + pigeon pea based intercropping cropping system

| Treatments | Bacteria (x 10 ⁶ Cfu g ⁻¹) | | | Fungi (x 10 ⁴ Cfu g ⁻¹) | | | Actinomycetes (x 10 ² Cfu g ⁻¹) | | |
|------------------|---|-------------|-------------|--|-------------|-------------|--|-------------|-------------|
| | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled |
| T ₁ | 9.54 | 11.01 | 10.28 | 6.03 | 7.10 | 6.57 | 4.20 | 5.00 | 4.60 |
| T ₂ | 12.00 | 13.80 | 12.90 | 6.50 | 7.83 | 7.17 | 4.01 | 5.43 | 4.72 |
| T ₃ | 13.53 | 13.90 | 13.72 | 7.50 | 8.90 | 8.20 | 4.42 | 5.80 | 5.11 |
| T ₄ | 13.50 | 14.04 | 13.77 | 8.00 | 9.30 | 8.65 | 4.53 | 6.31 | 5.42 |
| T ₅ | 17.50 | 18.70 | 18.10 | 10.50 | 11.21 | 10.86 | 6.00 | 6.80 | 6.40 |
| T ₆ | 16.92 | 18.21 | 17.57 | 10.00 | 10.72 | 10.36 | 5.81 | 6.12 | 5.97 |
| T ₇ | 8.50 | 10.11 | 9.31 | 5.80 | 6.30 | 6.05 | 3.10 | 3.60 | 3.35 |
| T ₈ | 9.80 | 11.50 | 10.65 | 7.00 | 8.50 | 7.75 | 4.50 | 5.43 | 4.97 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.53 | 0.54 | 0.38 | 0.34 | 0.39 | 0.26 | 0.27 | 0.31 | 0.21 |
| C.D.@ 5 % | 1.62 | 1.63 | 1.10 | 1.02 | 1.19 | 0.75 | 0.81 | 0.95 | 0.60 |

Legend:

| | |
|---|---|
| T₁: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₅: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ |
| T₂: 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₆: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ |
| T₃: 50 % K through Bio-K + 50 % K through K₂SO₄ + balance NP through fertilizers for targeted yield of 20 t ha⁻¹ | T₇: Recommended dose of fertilizers alone (75:75:100 kg NPK ha⁻¹) |
| T₄: 100 % K through K₂SO₄ + NP through fertilizers for targeted yield of 25 t ha⁻¹ | T₈: Package of Practice recommendation (UAS B) |

Significantly higher bacterial 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 (13.80 x 10⁵Cfu 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 (13.30 x 10⁵Cfu g⁻¹) as compared to other treatments. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (4.52 x 10⁵Cfu g⁻¹).

Fungal population was significantly higher with 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 25 t ha⁻¹ (8.36 x 10³ Cfu g⁻¹) as compared to other treatments. Significantly lower fungal population was observed in recommended dose of fertilizers alone (2.55 x 10³ Cfu g⁻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 (3.06 x 10² Cfu 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 (2.93 x 10² Cfu g⁻¹) and 100 % K through Bio-K + balance NP through fertilizers for targeted yield of 20 t ha⁻¹ (2.77 x 10² Cfu g⁻¹) as compared to other treatments. Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (1.20 x 10² Cfu g⁻¹) (Table 2). The results are in accordance with studies of Umesh (2008) in pigeon pea and Lingaraju (2018) in cowpea.

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 (18.10 x 10⁶ Cfu 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 (17.57 x 10⁶ Cfu g⁻¹) as compared to other treatments.. Significantly lower bacterial population was observed in recommended dose of fertilizers alone (9.31 x 10⁶ Cfu 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 (10.86 x 10⁴ Cfu 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 (10.36 x 10⁴ Cfu g⁻¹)^{as} compared to other treatments.

Significantly lower fungal population was observed in recommended dose of fertilizers alone (6.05 x 10⁴ Cfu 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 (6.40 x 10² Cfu 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 (5.97 x 10² Cfu g⁻¹) as compared to other treatments. Significantly lower actinomycetes population was observed in recommended dose of fertilizers alone (3.35 x 10² Cfu g⁻¹).

This increased microorganisms population might be attributed to increased availability of macro and micronutrients during the crop growth period due to addition of organic manure along with macronutrients and micro nutrients. Nitrogen fixation through free living nitrogen fixing rhizobium and mobilization of P and micronutrients along with addition of leaf litter and crop residues into the soil during reproductive stage which might have favoured increased population of microorganisms. Similar results were reported by Gitari *et al.*, (2019).

In potato + pigeon pea inter cropping system, after the potato harvesting, field bean showed higher microbial population under SSNM approach. This provides greater crop selections and sowing windows to the potato growing farmers of the zone.

References

- Felipe De Mendibur, 2020, *Agricolae*: Statistical procedures for agricultural research. R package version 1.3-3.
- Gitari, Harun I, Charles, K.K., Gachene, Nancy, N., Karnja, Solomon KAMAU, Shadrack Nyawade and Elmar Schulte Geldermann, 2019, Potato-legume intercropping on a sloping terrain and its effects on soil physic-chemical properties. *Plant Soil*, 440 (1-2):327-335.
- Gomez, K. A. and Gomez, A. A., 1984, *Statistical procedures for Agricultural Research*, 2nd Edition A Wiley Inter Science Publication. New York (USA).
- Lingaraju, N. N., 2018, response of maize-cowpea sequence to treated sugar mill effluent irrigation under different nutrient and moisture regimes in Cauvery command area. Ph.D. *Thesis*, University of Agricultural Sciences, Bangalore.
- Nyawade, Shadrack, O, Nancy, N. Karanja, Charles, K. K., Gachene, Harun, Elmar Schulte-Geldermann and Monica Parker, 2019, Short term dynamics of soil organic matter fractions and microbial activity in smallholder potato-legume intercropping systems. *Applied Soil Ecology*, 142: 123-135.
- Tiwari, K. N., Dwivedi, B. S., Singh, D., Swarup, A., Meena, M. C., Majumdar, K., Yadav, K. S. and Yadav, R. L., 2005, On-farm evaluation of SSNM in pearl millet based cropping systems on alluvial soils. *Better Crops*, 3(1): 25-27.
- Umesh, M. R., 2008, Investigation on balanced fertilization for maize pigeon pea cropping sequence in *Alfisols* of Karnataka. Ph.D. *Thesis*. University of Agricultural Sciences, Bengaluru.

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