Effect of integrated nutrient management on sweet corn–potato cropping system: Productivity, economic yield and soil nutrient balance

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Abstract

The study was conducted to estimate the productivity, economic yield and soil nutrient balance of integrated nutrient management in sweet corn-potato cropping sequence as was conducted during kharif and rabi season of 2014-15 to 2015-16 at Instructional Research Farm, Central Campus, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. The performance of sweet corn–potato cropping sequence was assessed in terms of residual fertility status at the end of two years crop sequence. The treatment T1-100% GRDF to preceding crop sweet corn during kharif season registered maximum net gain of nitrogen, phosphorus and potassium (+49.19, +6.54 and +80.74 kg ha⁻¹) at the end of two years experimentation.

Keywords: Sweet corn, cropping system, nutrient balance, potato, soil fertility

Introduction

Integrated nutrient management (INM), a combined application of organic and inorganic sources of nutrients, maintains storage of plant nutrients in soil and improves nutrients-use efficiency that is essential for sustainable crop production. Organic matter acts as a source and a sink for plant nutrients as well as provides energy substrate for soil micro-organisms. Thus, it enhances activities of soil flora and fauna as well as intrinsic soil properties, soil nutrient capital, water-holding capacity and soil structure in turn makes soil less susceptible to leaching and erosion. Therefore, INM practices are essential to maintain/enhance the soil quality and sustainability of an agro-ecosystem (Carter et al. 2004) [8]. Kharif maize often face terminal drought resulted crop failure or very less productivity. It may be overcome by growing the maize for sweet corn instead of green cob. Besides farmyard manure (FYM), now-a-days vermicompost is gaining attention of both the researchers and the farmers due to its immense production potential using farm. Vermicomposting is a biotechnological and mesophilic (10–32 °C) process of composting. This process is faster and safer than the conventional composting as the material passes through the earthworm gut resulting earthworm castings is rich in microbial activity and have plant growth regulators. Vermicompost can be utilized in crop production as a component of INM and as a single source of all essential crop nutrients (Bejbarrnaha et al., 2009) [10]. All nutrients in vermicompost are in readily available form, thereby, enhancing nutrients uptake by plants (Banik and Sharma 2009) [5]. Still the information on this aspect is meager therefore a study thus designed to evaluate the different nutrient management practices on productivity, economic yield and soil nutrient balance of sweet corn–potato cropping system.

Materials and Methods

The field experiment was conducted for two consecutive years at the Post Graduate Institute Research Farm, M.P.K.V., Rahuri (M.S.) during the year 2014-15 and 2015-16. It is observed that, the soil of experimental site was clayey in texture. The chemical composition according criteria laid by Muhr et al. (1965) [20] indicated that soil was low in available nitrogen (241.35 kg ha⁻¹), medium in available phosphorous (22.85 kg ha⁻¹) and very high in potassium (365.75 kg ha⁻¹). The experiment was laid out in Randomized Block Design with three replications. The treatment consisted T₁ – 100% GRDF, T₂ - 75% RDN + 25% N through FYM, T₃ - 75%...
The nutrient balance sheet was calculated by multiplying dry matter content of the crop through readily available nutrients from synthetic fertilizers at initial stage and later stages through mineralization of organic manure into available form of nutrients for crop (Sarkar et al., 2011; Kumar et al., 2012) [26]. Thus, higher potato yield might be due to higher residual soil fertility built-up by organic manure. The results are in conformity with the findings of reported by Congera et al. (2013) [10]; Najm et al. (2013) [21]; Narayan et al. (2013) [22]; Balemi (2014)[4] and Biruk et al. (2014) [7].

**Sweet corn equivalent yield (q ha⁻¹)**

The sweet corn equivalent yield was significantly influenced by the various fertilizer levels to preceding sweet corn crop. The treatment T₇-100%-GRDF registered maximum sweet corn equivalent yield over rest of treatments and was at par with treatment T₅-125% RDN + 25% N through FYM. This is mainly due to higher market price of sweet corn and potato as these crops were grown and harvested as vegetables. The sweet corn-potato system produced significantly maximum sweet corn equivalent yield mainly due to inclusion of high value crops like potato. These results are in close conformity with the findings of several other researchers from different Agro-climatic conditions (Singh et al., 2011 and Dubey et al., 2014) [27, 11]. The productivity of cropping system in term of sweet corn-equivalent yield (system productivity) was significantly higher in treatment T₇ - 100% GRDF (309.71, 329.99 and 319.85 q ha⁻¹) (Table 1). Mahavishnan et al. (2005) [19] and Gaur et al. (1984) [12] also reported that when FYM was applied at less than 30% N, about 60–70% P and 75% K become available to the immediate follow-up crop. Thus, higher potato yield might be due to higher residual soil fertility built-up by organic manure. The results are in conformity with the findings of Banik and Sharma (2009) [5] and Bejbaruha et al. (2009) [6].

**Nutrient balance sheet**

The nutrient balance after harvest of sweet corn and potato crop considered in sweet corn - potato crop sequence was assessed during the study period to check the gain or deficit observed due to use of organic and inorganic fertilizers. The nutrients viz., nitrogen, phosphorus and potassium balance sheet as affected by different treatments tried is presented in Table 2 after harvest of sequential crops.

**Effect of preceded crop**

The performance of sweet corn–potato cropping sequence was assessed in terms of residual fertility status at the end of two years crop sequence. The treatment T₇ -100% GRDF to
preceding crop sweet corn during *kharif* season registered minimum net loss of nitrogen (~38.50 kg ha\(^{-1}\)) and maximum gain of phosphorus and potassium (+0.88 and +33.69 kg ha\(^{-1}\)) than rest of other treatments and followed by treatment T\(_6\) - 125% RDN + 25% N through FYM minimum net loss of nitrogen (~43.00 kg ha\(^{-1}\)) and maximum gain of phosphorus and potassium (+0.43 and +33.20 kg ha\(^{-1}\)). The effects of INM on nutrient dynamics were recorded, and it was concluded that combining FYM with inorganic fertilizers could maintain available N and P at either equal to or greater than the initial soil nutrient levels, thus maintaining soil fertility even under continuous cultivation. Chaudhary, et al. (2009) [9]. The maximum loss of nitrogen and phosphorus (~49.63 and ~2.27 kg ha\(^{-1}\)) minimum gain of potassium (+27.76 kg ha\(^{-1}\)) was observed under treatment T\(_3\) - 75% RDN + 25% N through VC at the end of two years experimentation.

**Table 1**: Chemical properties experimental site

| S. No. | Particular | composition | Method adopted | References |
|--------|------------|-------------|---------------|------------|
| (A)    |            |             |               |            |
| 1      | Organic carbon (g kg\(^{-1}\)) | 0.51 | Walkley and Black’s rapid titration method | Piper (1966) |
| 2      | Available N (kg ha\(^{-1}\)) | 241.35 | Alkaline KMNO\(_4\) method | Subbiah and Asija (1956) |
| 3      | Available P₂O₅ (kg ha\(^{-1}\)) | 22.85 | 0.5 N NaHCO\(_3\) Ascorbic acid | Olsen and Dean (1965) |
| 4      | Available K₂O (kg ha\(^{-1}\)) | 365.75 | Flame photometer | Jackson (1973) |
| (B)    |            |             |               |            |
| 1      | Total N (%) | 1.02 | Macro-kjeldhalas method | A.O.A.C. (2005) |
| 2      | Total P₂O₅ (%) | 0.50 | Vanadomolybdate yellow colour method in nitric acid | Jackson (1973) |
| 3      | Total K₂O (%) | 0.80 | Flame photometer method | Knudsen et al. (1982) |
| (C)    |            |             |               |            |
| 1      | Total N (%) | 0.50 | Macro-kjeldhalas method | A.O.A.C. (1992) |
| 2      | Total P₂O₅ (%) | 0.20 | Vanadomolybdate yellow colour method in nitric acid | Jackson (1973) |
| 3      | Total K₂O (%) | 0.44 | Flame photometer method | Knudsen et al. (1982) |

**Table 1**: Effect integrated nutrient on yield of sweet corn, yield of potato and equivalent yield sweet corn equivalent yield (BCEY) of the system.

| Fertilizer levels to sweet corn | Treatment | Green cob yield (q ha\(^{-1}\)) | Green fodder yield (q ha\(^{-1}\)) | Tuber yield (q ha\(^{-1}\)) | Haum yield (q ha\(^{-1}\)) | Sweet corn equivalent yield (q ha\(^{-1}\)) |
|--------------------------------|-----------|-------------------------------|-------------------------------|----------------------------|----------------------------|---------------------------------|
|                                  | 100% GRDF | 265.25                        | 271.99                        | 527.85                      | 540.80                     | 280.21                          | 286.96                          | 12.31                           | 13.52                           | 309.71                          | 329.99                          |
| T\(_1\) : 75% RDN + 25% N through FYM | 249.75    | 256.25                        | 509.49                        | 520.60                      | 260.35                     | 272.35                          | 10.46                           | 10.54                           | 287.76                          | 313.20                          |
| T\(_2\) : 75% RDN + 25% N through VC  | 255.35    | 262.09                        | 518.36                        | 531.20                      | 255.71                     | 266.72                          | 10.31                           | 10.46                           | 282.63                          | 306.73                          |
| T\(_3\) : 100% RDN + 25% N through FYM | 258.45    | 264.84                        | 522.07                        | 534.76                      | 265.53                     | 276.51                          | 10.90                           | 11.12                           | 293.48                          | 317.99                          |
| T\(_4\) : 100% RDN + 25% N through VC  | 260.74    | 267.04                        | 524.09                        | 536.58                      | 261.65                     | 274.71                          | 10.66                           | 10.97                           | 289.19                          | 315.92                          |
| T\(_5\) : 125% RDN + 25% N through FYM | 271.94    | 277.49                        | 538.44                        | 546.82                      | 275.36                     | 282.11                          | 11.17                           | 12.26                           | 304.35                          | 325.43                          |
| T\(_6\) : 125% RDN + 25% N through VC  | 275.55    | 281.55                        | 542.83                        | 554.19                      | 271.55                     | 278.95                          | 11.06                           | 11.17                           | 300.13                          | 320.79                          |
| C. D. at 5%                       | 2.69      | 2.75                          | 3.26                          | 3.51                        | 2.47                       | 2.53                            | 0.41                            | 0.47                            | 2.75                            | 2.96                            |

**Fertilizer levels to potato**

| F\(_1\) : 75% GRDF | 264.66 | 274.75 | 10.69 | 10.95 | 292.52 | 315.96 |
| F\(_2\) : 100% GRDF | 270.21 | 279.60 | 10.98 | 11.64 | 298.65 | 321.54 |
| S. Em. ± | 2.44 | 1.04 | 0.13 | 0.11 | 1.03 | 0.88 |
| C. D. at 5% | NS | NS | NS | NS | NS | NS |
| Interaction | NS | NS | NS | NS | NS | NS |
| General mean | 267.44 | 277.18 | 10.83 | 11.29 | 295.59 | 318.75 |

**Table 2**: Soil nutrient balance sheet as influenced by different treatments after two years of sweet corn- potato sequence

| Treatment | Initial nutrient status | Nutrient added | Nutrient uptake | Apparent nutrient status | Actual nutrient status | Gain (+)/loss (-) |
|-----------|-------------------------|----------------|-----------------|--------------------------|------------------------|-------------------|
| A (N) | B (P) | K (K) | N (N) | P (P) | K (K) | N (N) | P (P) | K (K) | X=(A+B+C) | Y=D-A |
| T\(_1\) : 100% GRDF | 800.02 | 85.63 | 1317.13 | 854 | 290 | 558 | 799.92 | 101.55 | 532.08 | 761.52 | 86.51 | 1350.82 | 854.10 | 274.08 | 1343.05 | -38.50 | 0.88 | 33.69 |
| T\(_2\) : 75% RDN + 25% N through FYM | 760.16 | 82.22 | 1269.35 | 754 | 280 | 518 | 636.92 | 81.64 | 385.31 | 711.92 | 80.38 | 1299.87 | 877.27 | 280.58 | 1402.04 | -48.27 | -1.84 | 30.52 |
| T\(_3\) : 75% RDN + 25% N through VC | 748.51 | 81.72 | 1265.91 | 754 | 284 | 524 | 651.07 | 79.98 | 380.32 | 698.88 | 79.45 | 1293.67 | 851.44 | 285.74 | 1409.59 | -49.63 | -2.27 | 27.76 |
| T\(_4\) : 100% RDN + 25% N through FYM | 770.76 | 83.36 | 1276.99 | 814 | 280 | 518 | 721.58 | 91.13 | 443.26 | 726.51 | 82.35 | 1308.98 | 863.18 | 272.23 | 1351.73 | -44.25 | -1.01 | 31.99 |
| T\(_5\) : 100% GRDF | 766.05 | 83.06 | 1273.38 | 814 | 284 | 524 | 711.02 | 87.80 | 419.70 | 719.18 | 81.89 | 1304.05 | 869.03 | 269.26 | 1377.68 | -46.87 | -1.17 | 80.67 |
| Fertilizer levels to potato | RDN + 25% N through VC | T<sub>e</sub> | RDN + 25% N through FYM | T<sub>r</sub> |
|---------------------------|------------------------|---------|------------------------|---------|
| F<sub>i</sub> | 75% GRDF | 779.81 | 84.99 | 1300.43 | 874 | 280 | 518 | 808.33 | 101.50 | 525.54 | 736.81 | 85.42 | 1333.63 | 847.48 | 263.49 | 1292.89 | 43.00 | 0.43 | 33.20 |
| F<sub>j</sub> | 100% GRDF | 775.68 | 84.39 | 1279.88 | 874 | 284 | 524 | 812.84 | 99.80 | 489.90 | 730.56 | 84.23 | 1311.95 | 836.84 | 268.59 | 1313.98 | 43.32 | -0.16 | 32.07 |
| General mean | 771.90 | 83.65 | 1282.69 | 819.71 | 283.14 | 526.29 | 733.44 | 91.57 | 452.06 | 724.90 | 82.19 | 1313.21 | 858.17 | 275.23 | 1356.92 | 46.49 | -1.46 | 30.52 |

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