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National Academy of Agricultural Science (NAAS) Rating : 3. 03

# Effect of Integrated Nutrient Management Practices on Soil Properties in Groundnut + Hardwikia based Agri-Silvi System

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***Abstract:*** *A field study was conducted during two kharif seasons at Students' Farm on red sandy loam soil to study the performance of ground nut in hardwickia plantation under different integrated nutrient management and its effect on soil physical and chemical properties. The results showed that the pod yield of groundnut was significantly higher in solecropping than the intercropping of groundnut in unpollarded hardwickia. But the groundnut pod yields under pollarded hardwickia were atpar to that of solecropped groundnut. Maximum pod yield was obtained by application of recommended dose of NPK + vermicompost and enriched FYM with recommended dose of NPK during both the years. Physical and chemical properties of soil were found to be improved under intercropping situation in tree plantations. Available N, P and K contents in soil also considerably increased in soils of hardwickia plantations when compared to solecropping situation. N, P and K uptake by the crop increased to the greater extent and solecropping of groundnut compared to intercropping of groundnut in hardwickia plantations.*

***Keywords:*** *Hardwickia, Groundnut, Intercropping, Solecropping, pollarded.*

## INTRODUCTION

Traditional agriculture is organic based everywhere. In the modern agriculture, as the chemicals fancied the farmers, organic farming is neglected. To maintain soil health and to supply nutrients in balanced proportion for higher crop yields, it is imperative to practice integrated nutrient supply system through the combined use of organic, biological and chemical sources of nutrients. Escalating cost of inorganic fertilizers, their undesirable impact on the physical condition of soil, erratic rainfall and poverty call for immediate inclusion of organic sources in any rainfed cropping system. Soil fertility buildup through agroforestry and practice of integrated nutrient management were suggested as potential means to increase the soil fertility especially in drylands (Subba Reddy *et. al*., 1991). The agroforestry systems in which large quantity of nutrients are removed by the harvested produce is unlikely to be sustainable without fertilization (Szott and Kass, 1993).

Suitable alternate land use systems involving agriculture, horticulture, forestry and agroforestry has been designed with the support of local natural resources for almost identical hydrological behaviour as under the natural system. Sequestering carbon in tree biomass by way of integrating trees into landscapes as agroforestry, forestry and plantations is a cost-effective climate change mitigation strategy (Josep G. Canadell, *et. al.* 2008 and Prasad, *et. al.* 2012). Suitably selected trees in an agroforestry system enhance the system productivity and act as sink for atmospheric carbon. The system as a whole contributes to mitigate climate change with secondary benefits of food security, increased farm income, restored biodiversity, maintained watershed hydrology and improved soil health and people livelihood (Roy and Tewari, 2012 and Singh G *et. al*., 2007). Hence, to find out the ameliorative effects of trees and INM practices on physical and chemical properties of soil in different agroforestry systems this experiment were planned.

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## MATERIAL AND METHODS

A field experiment was conducted during two *kharif* seasons at Students' Farm, College of Agriculture, Rajendranagar, Hyderabad. The experimental site was under ten years old hardwickia plantation spaced at 4m × 4m. The soil in hardwickia plantation was red sandy loam, medium in organic carbon ranges (0.66-0.67%), available N (314.5-319 kg ha$^{-1}$), available P (37.4-38.2 kg ha$^{-1}$) and available K (236-237 kg ha$^{-1}$) during two years, whereas the open area was low in organic carbon (0.28-0.30%) and available N (189.8-190.3 kg ha$^{-1}$), medium in available P (26.4-26.8 kg ha$^{-1}$) and available K (216.5-217.4 kg ha$^{-1}$) during two years.

The treatments comprised of 3 cropping situations *viz.,* intercropping of groundnut in pollarded hardwickia, intercropping of groundnut in unpollarded hardwickia and solecropping of groundnut as main plots and seven integrated nutrient management practices as sub plots *viz.,* recommended dose of NPK (20:40:40), recommended dose of NPK + FYM (10 t ha$^{-1}$), recommended dose of NPK + vermicompost (2t ha$^{-1}$), enriched FYM (750 kg ha$^{-1}$) with recommended dose of NPK, 50% recommended dose of NPK + FYM (10 t ha$^{-1}$), 50% RDF + vermicompost (2 t ha$^{-1}$) and enriched FYM (750 kg ha$^{-1}$) with 50% RDF. The experiment was laid out in split plot design with three replications. The plot sizes were 4m × 4 m in intercropping and solecropping as well. Hardwickia trees were cut above 3 m height under the treatment of intercropping of groundnut in pollarded hardwickia during both the years of study. The groundnut variety TMV-2 was selected as a rainfed intercrop and sown at recommended spacing both in intercropping and solecropping situations. The total rainfall was received in the cropping season was 800 mm rainfall distributed in 41 rainy days during first year and 498 mm rainfall distributed in 35 rainy days during second year.

## RESULTS AND DISCUSSIONS

### Pod Yield

Pod yields increased to the maximum extent when groundnut was grown as solecrop in comparison with intercropping of groundnut in pollarded hardwickia trees by 20.7% and 140.9%, respectively during first year and by 28.0% and 127.8% respectively during second year. Whereas there was drastic decrease in both pod yields under intercropping situation when groundnut grown in unpollarded trees. Similar trend was observed in harvest index also. Greater yields were recorded in solecropped groundnut as well as intercropped groundnut in pollarded trees and this could be attributed to resultant effects of favourable plant growth and better yield attributes obtained in these situations where there was no competition absolutely on natural resources available. These results are in agreement with the findings of Bheemaiah and Subramanyaman (2002), Samsuzzaman *et. al.* (2002).

Among the integrated nutrient management practices studied, application of recommended dose of NPK with combination of vermicompost as well as enrichment of FYM recorded the maximum pod yields. However application of FYM along with recommended dose of NPK also was found effective in enhancement of pod yields when compared to application of 50% recommended dose of NPK with the combination of different organic manures. Higher pod yields obtained with recommended dose of NPK could be due to adequate supply of essential nutrients and also application of vermicompost and enrichment of FYM might have helped steady supply of nutrients because of favourable soil properties maintained throughout the crop growth period. Singh *et. al.* (2001) and Das (2002) stated that an increase in pod yield of groundnut due to recommended dose of fertilizer application with combination of organic manures which might be attributed to enhanced synthesis of carbohydrates and proteins.

### Effect of Cropping Situations on Soil Physical and Chemical Properties

The data on physical properties of soil showed that the soil under intercropping situation either in pollarded or unpollarded trees were improved resulting higher soil moisture status and low bulk density when compared to those of under solecropping situation (table 2). It might be due to the resultant effects of addition of leaf litter and root spread when the trees are grown in marginal lands which improve the physical properties of soil (Ballakki and Badanur, 1993).

**Table 1**
**Pod yield (kg ha$^{-1}$) of groundnut as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| | I year | | | | II year | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatments* | *Cropping Situations (CS)* | | | | *Cropping Situations (CS)* | | | |
| *Integrated Nutrient Management (INM)* | *IPH* | *IUPH* | *SC* | *Mean* | *IPH* | *IUPH* | *SC* | *Mean* |
| RDF (20:40:40 kg ha$^{-1}$) | 786.9 | 402.7 | 914.8 | 701.5 | 669.8 | 396.2 | 866.5 | 644.1 |
| RDF + FYM (10 t ha$^{-1}$) | 924.5 | 470.7 | 1047.8 | 814.3 | 755.2 | 464.8 | 966.4 | 728.8 |
| RDF + Vermi compost (2 t ha$^{-1}$) | 1027.1 | 528.7 | 1132.8 | 896.2 | 925.8 | 508.8 | 1079.8 | 838.2 |
| Enriched FYM (750 kg ha$^{-1}$) with RDF | 1017.1 | 494.0 | 1122.4 | 877.8 | 929.1 | 518.8 | 1083.0 | 843.6 |
| 50% RDF + FYM (10 t ha$^{-1}$) | 536.3 | 257.0 | 771.1 | 521.5 | 453.3 | 256.1 | 659.5 | 456.3 |
| 50% RDF +Vermi compost (2 t ha$^{-1}$) | 607.9 | 297.2 | 827.9 | 577.7 | 527.1 | 269.1 | 733.1 | 509.8 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% RDF | 597.3 | 304.7 | 820.7 | 574.2 | 524.8 | 275.5 | 737.5 | 512.6 |
| Mean | 785.3 | 393.6 | 948.2 | | 683.6 | 384.2 | 875.1 | |
| | *SEm±* | | *CD (P = 0.05)* | | *SEm±* | | *CD (P = 0.05)* | |
| CS | 32.73 | | 90.87 | | 23.29 | | 64.64 | |
| INM | 19.51 | | 39.58 | | 23.87 | | 48.43 | |
| CS × INM at main | 33.79 | | 68.56 | | 41.34 | | 83.89 | |
| CS × INM at sub | 81.19 | | 196.43 | | 59.13 | | 131.93 | |

IPH - Intercropping in pollarded hardwickia
IUPH - Intercropping in unpollarded hardwickia
SC - Solecropping
NS - Non Significant
RDF (recommended dose of NPK)

**Table 2**
**Physical and chemical properties of soil before and after cropping in both the years**

| | *Hardwickia plantations* | | | | *Open area (Sole)* | | | |
|---|---|---|---|---|---|---|---|---|
| *Physical and chemical properties of soil* | *I year* | | *II year* | | *I year* | | *II year* | |
| | *Before cropping* | *After cropping* | *Before cropping* | *After cropping* | *Before cropping* | *After cropping* | *Before cropping* | *After cropping* |
| Bulk density (g cm$^{-3}$) | 1.54 | 1.31 | 1.48 | 1.33 | 1.58 | 1.41 | 1.55 | 1.43 |
| P$^{H}$ (1:1.25 soil : water) | 6.7 | 6.7 | 6.7 | 6.7 | 7.0 | 7.0 | 7.0 | 7.0 |
| Electrical conductivity(dSm$^{-1}$ at 25°C) | 0.14 | 0.14 | 0.14 | 0.13 | 0.17 | 0.16 | 0.16 | 0.16 |
| Organic carbon (%) | 0.66 | 0.67 | 0.67 | 0.68 | 0.28 | 0.28 | 0.30 | 0.31 |

From the data of available N, P and K contents in soil, it was clearly noticed that the N, P and K contents in the soil improved under intercropping situation with hardwickia trees when compared to solecropping situation (table 3, 4 and 5). Intercropping of groundnut in unpollarded hardwickia enhanced available N, P and K contents in the soil to the maximum, because of constant addition of leaf litter and nitrogen fixing ability over the years from uncut trees under this intercropping situation ( Jha *et. al.*, 2000).

Total N and P uptake by the crop greatly increased when groundnut was grown as solecrop when compared to the intercropping situation in

**Table 3**
**Available N (kg ha$^{-1}$) in soil after harvest of groundnut as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| *Treatments* | *I year* | *II year* |
|---|---|---|
| *Cropping situations (CS)* | | |
| IPH | 348.3 | 336.2 |
| IUPH | 361.3 | 347.0 |
| SC | 243.8 | 229.9 |
| SEm± | 3.05 | 1.13 |
| CD (P = 0.05) | 11.99 | 4.44 |
| *Integrated nutrient management practices (INM)* | | |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 319.8 | 295.8 |
| Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 336.3 | 320.5 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 331.2 | 344.8 |
| Enriched FYM (750 kg ha$^{-1}$) with Recomm-ended dose of NPK | 343.6 | 329.3 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 282.4 | 273.2 |
| 50% Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 297.9 | 285.9 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 290.2 | 281.1 |
| SEm± | 4.10 | 5.17 |
| CD (P = 0.05) | 11.76 | 14.82 |
| CS × INM at main | | |
| SEm± | 7.10 | 8.95 |
| CD (P = 0.05) | NS | NS |
| CS × INM at sub | | |
| SEm± | 7.25 | 8.36 |
| CD (P = 0.05) | NS | NS |

hardwickia trees (table 6, 7 and 8). However, total N and P uptake by the crop also improved under intercropping situation in pollarded trees in comparison with intercropping situation in unpollarded trees by 34.6% and 18.1% in first year and 16.3% and 18.7% in second year, respectively. The improvement in uptake of N and P by the crop was mainly due to improvement in both seed and haulm yields recorded under solecropping situation. This could be further attributed to the competition of trees for nutrient absorption from the soil which might have caused a decline in uptake of nutrients by the crop under intercropping situations (Madhukar Rao, 2005).

## Effect of Integrated Nutrient Management Practices on Physical and Chemical Properties of Soil

The physical properties like soil moisture status and bulk density showed favourable improvement by the way of increasing soil moisture content and decreasing bulk density due to application of organic manures like vermicompost, enrichment of FYM and FYM with combination of NPK either at 100% or 50% recom mended dose of NPK when compared to recommended dose of NPK alone. These might be due to conjunctive use of organic and inorganic fertilizers which have improved the soil physical conditions and subsequently increased in nutrient status of soil. Similar results were obtained by Hegde (1998) and Ilaiah (2003).

Total available N, P and K contents in soil were considerably increased with application of organic manures like vermicompost, enrichment of FYM and FYM with combination of recommended dose of NPK when compared to recommended dose of NPK alone as well as 50% recommended dose of NPK with the combination of organic manures (table 3 , 4 and 5). This could be attributed to the added advantages of application of organic manures along with recommended dose of NPK which might have contributed in more availability of nutrients coupled with favourable status of soil physically and chemically. Goswami (1996) also stated that the available nutrient content by application of vermicompost as well as their rate of release was much higher and faster than the normal compost. Similarly Roy *et. al.*, (2001) reported that enriched FYM is recommended to rainfed crops, which require available P for their root proliferation to withstand the initial stages under dryland conditions.

Total uptake of N, P and K by groundnut was found to be maximum with the application recommended dose of NPK along with vermicompost as well as enrichment of FYM among all the integrated nutrient management practices studied ((table 6, 7 and 8). Application of FYM along with recommended dose of NPK was also found better in increasing total N, P and K uptake when compared to recommended dose of NPK alone. Application of 50% recommended dose of NPK with

**Table 4**

**Available P content (kg ha$^{-1}$) in soil after harvest of groundnut as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| | I year | | | | II year | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatments* | *Cropping Situations (CS)* | | | | *Cropping Situations (CS)* | | | |
| *Integrated Nutrient Management (INM)* | *IPH* | *IUPH* | *SC* | *Mean* | *IPH* | *IUPH* | *SC* | *Mean* |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 32.5 | 37.0 | 31.1 | 33.5 | 31.6 | 36.1 | 30.2 | 32.6 |
| Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 33.4 | 38.1 | 33.8 | 35.1 | 32.3 | 37.4 | 32.0 | 34.2 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 36.5 | 42.2 | 35.7 | 38.1 | 35.7 | 41.1 | 34.6 | 37.1 |
| Enriched FYM (750 kg ha$^{-1}$) with Recommended dose of NPK | 32.3 | 41.7 | 35.2 | 36.4 | 34.5 | 40.3 | 35.3 | 36.7 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 29.4 | 31.3 | 26.8 | 29.2 | 29.2 | 30.5 | 26.7 | 28.8 |
| 50% Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 31.5 | 32.3 | 30.1 | 31.3 | 30.4 | 31.4 | 27.7 | 29.8 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 30.4 | 31.9 | 28.1 | 30.1 | 30.2 | 30.8 | 28.3 | 29.8 |
| Mean | 32.3 | 36.4 | 31.5 | | 32.0 | 35.4 | 30.8 | |

| | *SEm±* | *CD (P = 0.05)* | *SEm±* | *CD (P = 0.05)* |
|---|---|---|---|---|
| CS | 0.53 | 2.07 | 0.23 | 0.91 |
| INM | 0.61 | 1.76 | 0.41 | 1.17 |
| CS × INM at main | 1.06 | 3.05 | .71 | 2.02 |
| CS × INM at sub | 1.12 | 3.20 | 0.69 | 1.99 |

**Table 5**

**Available K content (kg ha$^{-1}$) in soil after harvest of groundnut as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| | I year | | | | II year | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatments* | *Cropping Situations (CS)* | | | | *Cropping Situations (CS)* | | | |
| *Integrated Nutrient Management (INM)* | *IPH* | *IUPH* | *SC* | *Mean* | *IPH* | *IUPH* | *SC* | *Mean* |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 280.7 | 286.0 | 264.3 | 277.0 | 275.9 | 281.2 | 254.9 | 270.7 |
| Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 306.3 | 306.7 | 282.0 | 296.3 | 293.3 | 291.4 | 273.9 | 286.2 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 324.3 | 307.0 | 304.0 | 311.8 | 306.6 | 291.7 | 296.2 | 298.2 |
| Enriched FYM (750 kg ha$^{-1}$) with Recommended dose of NPK | 313.3 | 301.7 | 289.0 | 301.3 | 291.8 | 288.2 | 294.4 | 291.5 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 249.0 | 257.0 | 239.0 | 248.3 | 226.6 | 230.5 | 234.0 | 230.4 |
| 50% Recommended dose of NPK + Vermicompost (2t ha$^{-1}$) | 272.0 | 280.3 | 250.0 | 267.4 | 240.9 | 271.8 | 241.4 | 251.4 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 264.3 | 269.0 | 241.0 | 258.1 | 235.9 | 254.7 | 233.9 | 241.5 |
| Mean | 287.1 | 286.0 | 267.1 | | 267.2 | 272.8 | 261.3 | |

| | *SEm±* | *CD (P = 0.05)* | *SEm±* | *CD (P = 0.05)* |
|---|---|---|---|---|
| CS | 5.50 | NS | 1.73 | 6.77 |
| INM | 5.08 | 14.56 | 5.92 | 16.98 |
| CS × INM at main | 8.79 | NS | 10.26 | 29.41 |
| CS × INM at sub | 9.82 | NS | 9.65 | 27.67 |

**Table 6**
**Total N uptake (kg ha$^{-1}$) of groundnut at harvest as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| | I year | | | | II year | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatments* | *Cropping Situations (CS)* | | | | *Cropping Situations (CS)* | | | |
| *Integrated Nutrient Management (INM)* | *IPH* | *IUPH* | *SC* | *Mean* | *IPH* | *IUPH* | *SC* | *Mean* |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 179.1 | 161.3 | 183.4 | 174.6 | 177.9 | 160.4 | 183.0 | 173.8 |
| Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 182.3 | 163.6 | 186.6 | 177.5 | 179.9 | 162.6 | 185.6 | 176.0 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 187.1 | 168.4 | 196.2 | 183.9 | 183.4 | 165.1 | 195.4 | 181.4 |
| Enriched FYM (750 kg ha$^{-1}$) with Recommended dose of NPK | 187.8 | 168.1 | 196.6 | 184.2 | 182.6 | 163.7 | 195.0 | 180.4 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 164.5 | 131.1 | 173.9 | 156.5 | 163.0 | 130.2 | 173.0 | 155.4 |
| 50% Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 167.1 | 132.3 | 177.4 | 158.9 | 165.4 | 132.1 | 174.4 | 157.3 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 167.3 | 132.5 | 176.0 | 158.6 | 164.3 | 131.7 | 175.3 | 157.1 |
| Mean | 176.5 | 131.1 | 184.3 | | 173.8 | 149.4 | 183.3 | |

| | *SEm±* | *CD (P = 0.05)* | *SEm±* | *CD (P = 0.05)* |
|---|---|---|---|---|
| CS | 0.52 | 1.45 | 0.52 | 1.44 |
| INM | 1.05 | 2.13 | 0.91 | 1.85 |
| CS × INM at main | 1.82 | 3.68 | 1.58 | 3.20 |
| CS × INM at sub | 1.45 | 3.04 | 1.40 | 2.96 |

**Table 7**
**Total P uptake (kg ha$^{-1}$) of groundnut at harvest as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| | I year | | | | II year | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatments* | *Cropping Situations (CS)* | | | | *Cropping Situations (CS)* | | | |
| *Integrated Nutrient Management (INM)* | *IPH* | *IUPH* | *SC* | *Mean* | *IPH* | *IUPH* | *SC* | *Mean* |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 17.9 | 14.7 | 18.4 | 17.0 | 17.5 | 14.5 | 17.7 | 16.5 |
| Recommended dose of NPK +FYM (10 t ha$^{-1}$) | 19.2 | 15.6 | 20.3 | 18.4 | 18.4 | 14.6 | 20.6 | 17.9 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 21.4 | 18.0 | 22.7 | 20.7 | 20.9 | 17.4 | 21.2 | 19.8 |
| Enriched FYM (750 kg ha$^{-1}$) with Recommended dose of NPK | 20.7 | 17.2 | 20.9 | 19.6 | 20.4 | 16.3 | 20.5 | 19.0 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 13.4 | 11.7 | 13.9 | 13.0 | 12.8 | 11.3 | 13.7 | 12.6 |
| 50% Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 14.3 | 13.4 | 15.4 | 14.3 | 14.3 | 13.1 | 13.4 | 13.6 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 15.3 | 12.9 | 14.6 | 14.3 | 14.1 | 12.5 | 13.3 | 13.3 |
| Mean | 17.5 | 14.8 | 18.0 | | 16.9 | 14.2 | 17.2 | |

| | *SEm±* | *CD (P = 0.05)* | *SEm±* | *CD (P = 0.05)* |
|---|---|---|---|---|
| CS | 0.25 | 0.97 | 0.15 | 0.61 |
| INM | 0.49 | 1.39 | 0.27 | 0.78 |
| CS × INM at main | 0.84 | NS | 0.47 | 1.35 |
| CS × INM at sub | 0.82 | NS | 0.46 | 1.33 |

**Table 8: Total K uptake (kg ha$^{-1}$) of groundnut at harvest as influenced by cropping situations and integrated nutrient management practices in agrisilvicultural system**

| *Treatments* | *I year* | *II year* |
|---|---|---|
| *Cropping situations (CS)* | | |
| IPH | 145.1 | 142.1 |
| IUPH | 134.5 | 130.4 |
| SC | 137.6 | 132.8 |
| SEm± | 5.12 | 4.50 |
| CD (P = 0.05) | NS | NS |
| *Integrated nutrient management practices (INM)* | | |
| Recommended dose of NPK (20: 40: 40 kg ha$^{-1}$) | 139.6 | 136.0 |
| Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 139.1 | 142.2 |
| Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 161.9 | 153.8 |
| Enriched FYM (750 kg ha$^{-1}$) with Recommended dose of NPK | 156.1 | 148.3 |
| 50% Recommended dose of NPK + FYM (10 t ha$^{-1}$) | 117.5 | 116.3 |
| 50% Recommended dose of NPK + Vermicompost (2 t ha$^{-1}$) | 132.0 | 126.3 |
| Enriched FYM (750 kg ha$^{-1}$) with 50% Recommended dose of NPK | 127.1 | 122.7 |
| SEm± | 5.14 | 4.92 |
| CD (P = 0.05) | 10.44 | 9.98 |
| *CS × INM at main* | | |
| SEm± | 8.91 | 8.52 |
| CD (P = 0.05) | NS | NS |
| *CS × INM at sub* | | |
| SEm± | 12.99 | 11.49 |
| CD (P = 0.05) | NS | NS |

different organic manures combination showed reduction in total N, P and K uptake when compared to recommended dose of NPK alone or with the combination of organic manures. The higher nutrient uptake by the crop with proper dose of N, P and K was mainly due to improvement in vegetative and reproductive structures of the plant. Further, application of organic manures namely vermicompost and enrichment of FYM might have contributed in improving the availability of nutrients because of aggregation of soil particles with more pore space and better aeration resulting in higher uptake of nutrients by the crop (Tolessa *et. al.*, 2001).

## CONCLUSION

The conjunctive use of organic and inorganic fertilizers clearly showed better response of groundnut crop when grown in rainfed areas, because of adequate supply of nutrients coupled with improvement of soil physical and chemical properties. Application of organic manures like FYM, vermicompost and enriched FYM along with 100% recommended dose of NPK showed favourable results on performance of groundnut grown either as solecrop or intercrop in tree plantation when compared to those with 50% recommended dose of NPK.

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