

## **Review Paper**

### **Possibility of Allelopathic and Residues Effects of The Rotated Crops on Productivity, Chemical Composition, Nitrogen Utilization of Wheat and Soil Fertility.**

#### **Abstract**

There is a long period between preceding crops (summer crops harvesting) such as rice and (winter crops) such as wheat crop sowing which causes fallow the land without agriculture. So in this period we can sow legume crop as a forage crop to animals before sowing wheat crop which improves soil properties and its availability and consider additional revenue to farmer. Fahlberseem had been sown in the end of August month after rice crop to produce approximately 20 ton fresh forage.fed<sup>-1</sup> (~ 9 ton dry fodder.fed<sup>-1</sup>) which provides farmers with (~ 9 thousands EL) in 75 days only. Also, Drawa had been sown in the same time after rice crop to produce 4.2-7.5 ton green maize.fed<sup>-1</sup> with low cost.

A field study was carried out at Sakha Agricultural Research Station farm, ARC, Kafr El-Sheikh governorate, Egypt, during two successive seasons of 2016/2017 and 2017/2018 to evaluate the possibility of allelopathic effects of the rotated crops on productivity, chemical composition, N utilization of wheat and soil fertility.

The local wheat cultivar (Sids 12) was sown after three crops (fahlberseem) after rice, (Drawa) after rice and Fallow after rice as preceded crops. A split plot design with three replications was used. The main plots were assigned with three previous crops, The sub plots were assigned by three nitrogen fertilizer rates (0, 35 and 70 kg N fed<sup>-1</sup>) the results showed that fahlberseem roots and residues in the clover (berseem)-wheat rotation secreted biologically active chemical compounds which have a positive effect on growth and development of wheat. The preceding clover (fahlberseem) wheat rotation appeared to be promising for wheat productivity, N, P, K concentrations, N-uptake, N utilization, protein content of wheat grain and straw, availability of N, P and K after wheat harvest compared with fallow after rice, green maize (drawa-wheat rotation). The interaction between the preceded crops and N fertilizer rates was significant for all the studied traits. The highest performance of wheat traits were observed when wheat was grown after fahlberseem and fertilized with 70 kg N.fed<sup>-1</sup>. While the lowest performance was obtained following cereal crops rice (fallow) and the lowest N level in both seasons. Treatment of fahlberseem with nitrogen fertilizer (70 kg N.fed<sup>-1</sup>) had given a best values from grain yield with relative increments of (37.54%)

compared with preceding rice-wheat rotation and (23.26%) compared with rice-drawa rotation.

Keywords: Allelopathy, Preceded crops, N rates, rice ,drawa, fahlberesem, wheat.

## 1. INTERODACTION (INTRODUCTION)

Rice-wheat cropping system is one of the most important cropping systems in Egypt. Both rice and wheat crop are highly nutrient exhaustive and therefore, causing deficiency of several nutrients [28].

The hypothesis was presumed that harvesting rice in 5<sup>th</sup> -10<sup>th</sup> day period of August thus improving both, yield and quality. On the other hand, there is a long period between preceding crops (summer crops harvesting) such as rice and (winter crops) such as wheat crop sowing which causes fallow the land without agriculture So in this period we can sow legume crop as a forage crop to animals before sowing wheat crop which improve soil properties, growth and development of wheat[17]and consider additional revenue to farmer. Fahlbarseem (Is it in English?) had be sown in the end of august month after rice crop to produce approximetly 20 ton fresh forage.fed<sup>-1</sup> ( ~ 9 ton dry forage fed<sup>-1</sup>) which provides farmers with (~ 9 thousands EL) in 75 days only.Also, Draw had be sown in the same time after rice crop to produce 4.2-7.5 ton green maize.fed<sup>-1</sup> with low cost.

Forage legumes, such as Berseem, (Is it in English?) were grown on a large number of acres. They differ markedly from grasses, cereals and other non-legume crops because much of the nitrogen they require is produced through fixation of atmospheric nitrogen by bacteria in nodules on their roots. Soil organic reserves declined due to cereal cropping and frequent fallowing. This resulted in an increase in green manure, thus an increase in the importance of legumes growing concerns about declining organic matter, soil fertility and rising energy and nitrogen fertilizer costs have led to renewed interest in legumes. Thus, the role of legumes as a nitrogen supplier in the rotation and as a builder of soil organic matter will likely gain importance in the future, [7].

Fahlberseem can fix 45.36 to 90.72 kg. N/A or more. It establishes well with an oat nurse crop, making it an excellent cover for small grain, corn, soybean rotations in the Midwest. [8].

Allelopathy is an interference mechanism, in which living or dead plant materials release allelochemicals exerting an effect on the associatd plants, and can play an important role in natural ecosystems [12].

Root exudate is one of the ways for plant communication to the neighboring plant and adjoining of microorganisms present in the rhizosphere of the root. The chemicals ingredients of the root exudates are specific to a

particular plant species and also depend on the nearby biotic and abiotic environment. A survey of the literature exposes an extensive range of compounds exuding from intact and healthy roots; these include sugars, peptides, amino acids, enzymes, vitamins, organic acids, nucleotides, fungal stimulators, inhibitors and attractants, eelworm hatching and attracting factors and many miscellaneous compounds. Organic acids, sugars, amino acids, lipids, coumarins, flavonoids, proteins, enzymes, aliphatics and aromatics are examples of the primary substances found within rhizosphere of the root. Among them, the organic acids have received considerable attention due to their role in providing substrates for microbial metabolism and for serving as intermediates for biogeochemical reactions in soil [24] and [6].

Root exudation is an element of the rhizodeposition process, which is a major source of soil organic carbon released by plant roots [15] and [23]. Upon assembling a challenge, roots typically respond by secreting certain small molecules and proteins [32] and [33]. Root secretions may play both positive and negative communication in the rhizosphere. The positive communication includes symbiotic associations with beneficial microbes, such as *mycorrhizae*, *rhizobia* and plant growth promoting *rhizobacteria* (PGPR). Negative interactions include association with parasitic plants, pathogenic microbes and invertebrate herbivores. The rhizospheric bacteria are responsible for the elimination of the contaminants while the roots are responsible for providing nutrients (root exudates) used by the microorganisms to proliferate [4].

The objective of this experiment was to determine the effect of preceding crop and nitrogen fertilizer rate on productivity, chemical composition, soil fertility and N utilization of wheat.

## 2. MATERIALS AND METHODS

A field experiment was carried out in a clayey textured soil (Clayey, Smectitic, Superactive, Mesic, Typic) located at Sakha Agricultural Research Station farm, Kafr El-Sheikh Governorate, Egypt (30° 56' N latitude and 31° 05' E longitude) to investigate the effect of cereal crops (summer crops) and legume (winter crop)-wheat rotation. one summer crop (rice) and one winter crop (wheat) was sown and two forage crops (fahlberseem and drawa) between rice and wheat were sown. The first experiment was initiated in 2016 summer season and terminated in 2016-2017 the winter season whereas; initiation and termination of the second experiments were summer and winter seasons of 2017 and 2018, respectively. some physical and chemical properties were determined according to [16] and [5]. Some soil chemical and physical properties (Table 1).

**Table 1. Some chemical and physical properties of the experimental soil (0-60 cm).**

| seasons         | Partical size distribert |       |       | Texture | pH 1:2.5 | EC Soil paste Ex. Ds.m <sup>-1</sup> | Cation soluble.meq.L <sup>-1</sup> |                  |                 |                | Anion soluble meq. L <sup>-1</sup> |                               |      |                              |
|-----------------|--------------------------|-------|-------|---------|----------|--------------------------------------|------------------------------------|------------------|-----------------|----------------|------------------------------------|-------------------------------|------|------------------------------|
|                 | Sand%                    | Silt% | Clay% |         |          |                                      | Ca <sup>++</sup>                   | Mg <sup>++</sup> | Na <sup>+</sup> | K <sup>+</sup> | CO <sub>3</sub> <sup>'</sup>       | HCO <sub>3</sub> <sup>'</sup> | cl   | SO <sub>4</sub> <sup>'</sup> |
| 1 <sup>st</sup> | 18                       | 30.8  | 51.2  | clayey  | 8.08     | 2.92                                 | 9.3                                | 8.5              | 10.1            | 1.7            | -                                  | 2.4                           | 14.5 | 13                           |
| 2 <sup>nd</sup> | 18                       | 31.3  | 52.7  | clayey  | 7.96     | 2.76                                 | 8.5                                | 7.7              | 9.8             | 1.7            | -                                  | 2.1                           | 13.7 | 12                           |

**Table 2. Some available nutrients mg.kg<sup>-1</sup> of the experimental soil (0-60cm) after preceding crops.**

| Treatments  | Available nutrients mg.kg <sup>-1</sup> |                 |                 |                 |                 |                 | O.M %           |                 |
|-------------|-----------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|             | N                                       |                 | P               |                 | K               |                 |                 |                 |
|             | 1 <sup>st</sup>                         | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| Rice        | 34                                      | 35.2            | 16              | 17              | 255             | 269             | 1.56            | 1.61            |
| Drawa       | 36.2                                    | 37.9            | 17.2            | 18.5            | 267             | 292             | 1.67            | 1.78            |
| Fahlberseem | 40                                      | 42              | 25              | 26.7            | 423             | 432             | 1.82            | 1.95            |

**You should interpret the results of table2**

Harvesting date of the previous crops at two seasons :

- Rice 20 August 2016 in 1<sup>st</sup> season and 20 August in 2<sup>nd</sup> season.
- Berseem fahl was sown in 25 august 2016 in 1<sup>st</sup> season and 22 August 2017 in 2<sup>nd</sup> season, and harvested in 20 Nov.
- Drawa was sown in 25 august 2016 in 1<sup>st</sup> season and 22 August 2017 in 2<sup>nd</sup> season, and harvested in 20 Nov.
- Wheat 25 Nov 2016 to 30 May 2017 in 1<sup>st</sup> season and 20 Nov 2017 to 25 May 2018 in 2<sup>nd</sup> season.

A split plot design was used with three replicates. The preceding crops (rice, drawa and fahlberseem) comprised the main plots and three nitrogen fertilizer levels (N1=0, N2=35 and N3=70 kg N.fed<sup>-1</sup>.) were tried in the sub-plots in the form of urea (46.5%) in two equal doses, the first dose was at Mohayah irrigation (30 days after sowing); while the second addition was at the second irrigation after Mohayah irrigation directly (30 days after the first addition). Phosphorus fertilizer was applied during soil preparation in the form of Calcium supr phosphate (15.5% P<sub>2</sub>O<sub>5</sub>) at a rate 15 kg P<sub>2</sub>O<sub>5</sub>.fed<sup>-1</sup>. Potassium at the rate of 24 kg K<sub>2</sub>O.fed<sup>-1</sup> in the form of potassium sulphate (48% K<sub>2</sub>O).

. wheat (C.V. Sids 12) was sown following the three preceding crops as a relay crop.

Plot was 24 m<sup>2</sup> in area (4 m long and 6 m in width). The preceding crop residues on plots were shredded by tillage that consisted of disking twice 10-15 cm deep before planting wheat. At the second year, wheat was planted following preceding crops with arrow spacing of 15 cm and a seeding rate 55 kg grains.fed<sup>-1</sup>

At harvest a 1.00 m<sup>2</sup> portion at the center of each wheat sub plot was sampled. From these samples total dry matter and grain weight were determined by drying the sampled plants at 70°C for 72h. The harvest index and yield components (grain yield, spike number/m<sup>2</sup>, spike seed number and 1000 grain weight) were measured. N utilization rate was calculated according to the following equation N utili. = N uptake for treatment - N uptake for control / N applied for treatment [11].

Soil sample were taken after harvesting to Determine some available elements. Available nitrogen of the soil was extracted by 1N potassium chloride and determined by Kjeldahl method [16], phosphorus was extracted by 0.5N sodium bicarbonate and calorimetrically measured by spectrophotometer [16]. Available potassium was extracted by 1N ammonium acetate and measured by flame photometer [16]. Grain and straw samples oven dried 70°C and ground thoroughly, wet digested using sulphuric and perchloric acids mixture, total nitrogen , total phosphorus , total potassium were determined according to [16].

The analysis of variance was carried out for each character in each season as out lined by [13]. The differences between the means of different treatment were tested using (LSD) at 5% level of probability were used to compare between treatments means.

### 3. RESULTS AND DISCUSSIONS

**Table (3): Plant height (cm),spike length(cm)and number of spike/m<sup>2</sup>, of wheat as affected by the remnants of thepreceding crops, mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

| Treatments               | Plant height (cm) |                 | spike length (cm) |                 | number of spike/m <sup>2</sup> |                 |
|--------------------------|-------------------|-----------------|-------------------|-----------------|--------------------------------|-----------------|
|                          | 1 <sup>st</sup>   | 2 <sup>nd</sup> | 1 <sup>st</sup>   | 2 <sup>nd</sup> | 1 <sup>st</sup>                | 2 <sup>nd</sup> |
| <b>A-preceding crops</b> |                   |                 |                   |                 |                                |                 |
| Rice (fallow)            | 85.7              | 87.5            | 10.0              | 10.1            | 332.3                          | 330.4           |
| Drawa                    | 86.3              | 89.6            | 10.5              | 10.5            | 351.5                          | 354.0           |
| FahlBerseem              | 91.5              | 95.4            | 10.6              | 10.9            | 383.2                          | 385.1           |
| <b>L.S.D at 0.05</b>     | <b>1.582</b>      | <b>1.712</b>    | <b>0.208</b>      | <b>0.326</b>    | <b>8.330</b>                   | <b>7.7641</b>   |
| <b>F.T.</b>              | <b>**</b>         | <b>**</b>       | <b>**</b>         | <b>**</b>       | <b>**</b>                      | <b>**</b>       |

| <b>B- N-fertilization levels</b> |              |              |           |           |           |           |
|----------------------------------|--------------|--------------|-----------|-----------|-----------|-----------|
| Control                          | 80.9         | 84.2         | 9.3       | 9.4       | 346.4     | 348.0     |
| 35                               | 85.5         | 87.8         | 10.5      | 10.7      | 355.8     | 357.7     |
| 70                               | 97           | 100.6        | 11.3      | 11.4      | 364.9     | 363.8     |
| <b>L.S.D at 0.05</b>             | <b>2.921</b> | <b>3.165</b> | <b>-</b>  | <b>-</b>  | <b>-</b>  | <b>-</b>  |
| <b>F.T.</b>                      | <b>**</b>    | <b>**</b>    | <b>NS</b> | <b>NS</b> | <b>NS</b> | <b>NS</b> |

Data presented in Table 3 show that, wheat cultivated after fahlberseem had the highest values of plant height (91.5 and 95.4 cm), spike length (10.6 and 10.9 cm) and number of spikes/m<sup>2</sup> (383.2 and 385.1) in the first and second season, respectively.

On the other hand, the lowest values of the mentioned traits were recorded with wheat after rice as a previous crop in both seasons.

In respect to nitrogen levels the highest values of the plant height (97 and 100.6 cm), spike length (11.3 and 11.4 cm) and number of spikes/m<sup>2</sup> (364.9 and 363.8) was obtained with 70 kg N fed<sup>-1</sup> in the first and second season, respectively. On the other hand the lowest values were recorded with the control treatment (without N fertilization).

**Table (4): Plant height (cm), spike length (cm) and number of spike/m<sup>2</sup>, of wheat as affected by the interaction between remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016/2017 and 2017/ 2018 seasons.**

| <b>Treatments</b>   |             | <b>Plant height (cm)</b> |                       | <b>spike length (cm)</b> |                       | <b>number of spike/m<sup>2</sup></b> |                       |
|---------------------|-------------|--------------------------|-----------------------|--------------------------|-----------------------|--------------------------------------|-----------------------|
|                     |             | <b>1<sup>st</sup></b>    | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>    | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>                | <b>2<sup>nd</sup></b> |
| <b>Rice(fallow)</b> | <b>Zero</b> | 78.7                     | 80.8                  | 9.1                      | 9.6                   | 321.9                                | 365.3                 |
|                     | <b>35</b>   | 79.8                     | 84.7                  | 9.3                      | 9.7                   | 326.3                                | 376.9                 |
|                     | <b>70</b>   | 84.3                     | 85.4                  | 9.5                      | 9.9                   | 343.6                                | 391.8                 |
| <b>Drawa</b>        | <b>Zero</b> | 85.0                     | 87.1                  | 10.4                     | 10.4                  | 348.5                                | 378.5                 |
|                     | <b>35</b>   | 85.0                     | 87.2                  | 10.2                     | 10.9                  | 351.9                                | 382.2                 |
|                     | <b>70</b>   | 86.5                     | 90.9                  | 11.2                     | 11.4                  | 359.2                                | 396.3                 |
| <b>FahlBerseem</b>  | <b>Zero</b> | 93.3                     | 96.4                  | 11.5                     | 11.8                  | 373.6                                | 385.6                 |
|                     | <b>35</b>   | 94.0                     | 97.0                  | 11.8                     | 12                    | 381.8                                | 390                   |

|                      |           |              |              |           |           |           |           |
|----------------------|-----------|--------------|--------------|-----------|-----------|-----------|-----------|
|                      | <b>70</b> | 103.6        | 108.3        | 11.8      | 12.4      | 394.3     | 399.9     |
| <b>L.S.D at 0.05</b> |           | <b>2.921</b> | <b>3.165</b> | -         | -         | -         | -         |
| <b>F.T</b>           |           | <b>**</b>    | <b>**</b>    | <b>NS</b> | <b>NS</b> | <b>NS</b> | <b>NS</b> |

The interaction between the previous crops and nitrogen fertilizer levels show that after fahlberseem and 70 Kg N had the highest plant height values (103.6 and 108.3 cm)

Try to interpret why?

and no significant differences were recorded in spike length and spike number/m<sup>2</sup> due to the interaction.

These results agree with [37] who found that plant height, spike length, number of spike/m<sup>2</sup> did not affected by the preceding crops under nitrogen fertilizer levels.

Compare the results of the 1<sup>st</sup> and the 2<sup>nd</sup> saison

**Table (5): number of grains/spike, weight of. grains/spike (gm) and weight of 100 grain (gm), of wheat as affected by the remnants of the preceding crops or previous crops, mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

| Treatments                       | number of grains/spike |                 | Weight of grains/spike(gm) |                 | weight of 100 grain (gm) |                 |
|----------------------------------|------------------------|-----------------|----------------------------|-----------------|--------------------------|-----------------|
|                                  | 1 <sup>st</sup>        | 2 <sup>nd</sup> | 1 <sup>st</sup>            | 2 <sup>nd</sup> | 1 <sup>st</sup>          | 2 <sup>nd</sup> |
| <b>A-preceding crops</b>         |                        |                 |                            |                 |                          |                 |
| Rice (fallow)                    | 38.1                   | 37.9            | 2.4                        | 2.3             | 4.7                      | 4.6             |
| Drawa                            | 42.5                   | 43.7            | 4.6                        | 4.7             | 4.9                      | 5.0             |
| FahlBerseem                      | 43.3                   | 45.1            | 5.3                        | 5.7             | 4.9                      | 5.1             |
| <b>L.S.D at 0.05</b>             | <b>0.927</b>           | <b>0.837</b>    | <b>0.214</b>               | <b>0.219</b>    | <b>-</b>                 | <b>0.162</b>    |
| <b>F.T.</b>                      | <b>**</b>              | <b>**</b>       | <b>**</b>                  | <b>**</b>       | <b>NS</b>                | <b>**</b>       |
| <b>B- N-fertilization levels</b> |                        |                 |                            |                 |                          |                 |
| Control                          | 39.0                   | 45.1            | 3.5                        | 3.6             | 4.4                      | 4.5             |
| 35                               | 41.0                   | 43.7            | 4.1                        | 4.2             | 5.0                      | 5.0             |
| 70                               | 43.9                   | 37.9            | 4.8                        | 4.9             | 5.1                      | 5.2             |

|                      |              |              |              |              |              |              |
|----------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>L.S.D at 0.05</b> | <b>0.927</b> | <b>0.837</b> | <b>0.046</b> | <b>0.219</b> | <b>0.186</b> | <b>0.162</b> |
| <b>F.T.</b>          | <b>**</b>    | <b>**</b>    | <b>**</b>    | <b>**</b>    | <b>**</b>    | <b>**</b>    |

Data presented in Table 5 show that, wheat cultivated after fahlberseem had the highest values of number of grains/*spike* (43.3 and 45.1), Weight of grains/*spike* (5.3and 5.7gm) in the first and second season, respectively and weight of 100 grain (5.1gm) in the second season only.

On the other hand, the lowest values of the mentioned traits were recorded with wheat after rice as a previous crop in both seasons.

In respect to nitrogen levels the highest values of the grains/*spike*(43.981 and 37.998), Weight of grains/*spike*(4.8 and 4.9gm) and weight of 100 grain(5.1and 5.2gm) was obtained with 70 kg N fed<sup>-1</sup> in the first and second season, respectively. On the other hand the lowest values were recorded with the control treatment (without N fertilization).

| Treatments   |             | number of grains/ <i>spike</i> |                 | Weight of grains/ <i>spike</i> (gm) |                 | weight of 100 grain (gm) |                 |
|--------------|-------------|--------------------------------|-----------------|-------------------------------------|-----------------|--------------------------|-----------------|
|              |             | 1 <sup>st</sup>                | 2 <sup>nd</sup> | 1 <sup>st</sup>                     | 2 <sup>nd</sup> | 1 <sup>st</sup>          | 2 <sup>nd</sup> |
| Rice(fallow) | <b>Zero</b> | 34.6                           | 34.4            | 2.2                                 | 2.1             | 4.2                      | 4.7             |
|              | <b>35</b>   | 38.3                           | 38.3            | 2.5                                 | 2.5             | 4.4                      | 4.7             |
|              | <b>70</b>   | 41.2                           | 41.1            | 2.7                                 | 2.5             | 4.5                      | 4.8             |
| Drawa        | <b>Zero</b> | 41.3                           | 41.9            | 3.7                                 | 3.9             | 4.9                      | 4.8             |
|              | <b>35</b>   | 41.4                           | 42.2            | 4.5                                 | 4.6             | 5.0                      | 4.9             |
|              | <b>70</b>   | 42.6                           | 43.1            | 4.6                                 | 4.9             | 5.0                      | 5.1             |
| FahlBerseem  | <b>Zero</b> | 44.2                           | 44.8            | 5.3                                 | 5.6             | 5.1                      | 5.2             |
|              | <b>35</b>   | 46.2                           | 46.0            | 5.7                                 | 5.3             | 5.2                      | 5.3             |
|              | <b>70</b>   | 42.6                           | 48.1            | 6.2                                 | 6.6             | 5.2                      | 5.4             |

|                      |              |           |              |              |           |           |
|----------------------|--------------|-----------|--------------|--------------|-----------|-----------|
| <b>L.S.D at 0.05</b> | <b>1.714</b> | <b>-</b>  | <b>0.397</b> | <b>0.405</b> | <b>-</b>  | <b>-</b>  |
| <b>F.T</b>           | <b>*</b>     | <b>Ns</b> | <b>**</b>    | <b>**</b>    | <b>Ns</b> | <b>Ns</b> |

**Table (6): number of grains/spike, weight of. grains/spike (gm) and weight of 100 grain (gm), of wheat as affected by the interaction between remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

The interaction between the previous crops and nitrogen fertilizer levels show that after fahlberseem and 70 Kg N had the highest number of grains/spike values (42.6 cm) and in first season only and Weight of grains/spike (6.2 and 6.6gm) in the first and second season, respectively and no significant differences were recorded in weight of 100 grain (gm) due to the interaction.

This result may be interpreted according to C/N ratio in soil because the microorganisms in soil such as bacteria need to nitrogen to live and analyzes the residual of preceding crops such as straw, this will reduce the available nitrogen which effect on growth yield, reduce their values.

**These results agree with** [37] and [17], studied the effect of preceding crops and nutrient management on growth and productivity of wheat. They indicated that growing legume crop as the preceding crop resulted significant higher parameters of wheat than preceding maize crop.

**Table (7): grain yield ardb.fed<sup>-1</sup> and straw yield ton.fed<sup>-1</sup> of wheat as affected by the remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

| <b>Treatments</b> | <b>Grain yield<br/>ar db.fed<sup>-1</sup></b> |                       | <b>Straw yield<br/>ton.fed<sup>-1</sup></b> |                       |
|-------------------|-----------------------------------------------|-----------------------|---------------------------------------------|-----------------------|
|                   | <b>1<sup>st</sup></b>                         | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>                       | <b>2<sup>nd</sup></b> |

| <b>A-preceding crops</b>        |             |             |             |             |
|---------------------------------|-------------|-------------|-------------|-------------|
| Rice (Fallow)                   | 17.02       | 16.94       | 1.98        | 2.156       |
| Drawa                           | 19.65       | 20.61       | 2.75        | 3.146       |
| FahlBerseem                     | 22.86       | 24.17       | 3.25        | 4.388       |
| <b>L.S.D at 0.05</b>            | <b>6.46</b> | <b>7.58</b> | <b>0.02</b> | <b>0.30</b> |
| <b>F.T.</b>                     | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>   |
| <b>B- N-fertilization level</b> |             |             |             |             |
| Control                         | 18.71       | 19.18       | 2.471       | 2.858       |
| 35                              | 19.44       | 20.20       | 2.67        | 3.256       |
| 70                              | 21.39       | 22.35       | 2.84        | 3.576       |
| <b>L.S.D at 0.05</b>            | <b>4.89</b> | <b>2.21</b> | <b>0.02</b> | <b>0.18</b> |
| <b>F.T.</b>                     | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>   |

- Ardb=150 kg

Compare the results of Drawa and Fahlberseem

The results of B - N-fertilization level (70) are under those of FahlBerseem , you should conclude

Generally, data in Table 7 show the values of grain and straw yields in both seasons as affected by preceding crops and mineral nitrogen fertilizer levels. The data indicated that preceding crops had a significant effect of grain and straw yields. Treatment of preceding fahlberseem had given abest values from yield (22.86 and 24.17) ardb.fed<sup>-1</sup> in the first and second season respectively. The effect of recommended dose (70 kg N.fed<sup>-1</sup>)level on grain and straw yields were highly significant, where the control treatment had the lowest values.

**Table 8: grain yield ardb.fed<sup>-1</sup> and straw yield ton.fed<sup>-1</sup> of wheat as affected by the interaction between remnants of the (preceding crops ), mineral nitrogen fertilizer levels during 2016 / 2017-and 2017 / 2018 seasons.**

| <b>Treatments</b>   |             | <b>Grain yield<br/>ar db.fed<sup>-1</sup></b> |                       | <b>Straw yield<br/>ton.fed<sup>-1</sup></b> |                       |
|---------------------|-------------|-----------------------------------------------|-----------------------|---------------------------------------------|-----------------------|
|                     |             | <b>1<sup>st</sup></b>                         | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>                       | <b>2<sup>nd</sup></b> |
| <b>Rice(fallow)</b> | <b>Zero</b> | 15.60                                         | 15.4                  | 1.69                                        | 1.66                  |

|                      |             |               |               |              |            |
|----------------------|-------------|---------------|---------------|--------------|------------|
|                      | <b>35</b>   | 17.09         | 17.00         | 2.04         | 2.20       |
|                      | <b>70</b>   | 18.38         | 18.43         | 2.22         | 2.51       |
|                      | <b>Zero</b> | 19.10         | 19.90         | 2.73         | 2.87       |
| <b>Drawa</b>         | <b>35</b>   | 19.36         | 19.98         | 2.75         | 3.05       |
|                      | <b>70</b>   | 20.51         | 21.97         | 2.77         | 3.52       |
|                      | <b>Zero</b> | 21.45         | 22.26         | 2.99         | 4.04       |
| <b>FahlBerseem</b>   | <b>35</b>   | 21.86         | 23.62         | 3.22         | 4.42       |
|                      | <b>70</b>   | 25.28         | 26.64         | 3.54         | 4.7        |
| <b>L.S.D at 0.05</b> |             | <b>8.4766</b> | <b>3.8354</b> | <b>0.045</b> | <b>-</b>   |
| <b>F.T.</b>          |             | <b>**</b>     | <b>**</b>     | <b>**</b>    | <b>N.S</b> |

The data obtained from Table 8 show that a significant effect of the interaction between preceding crops and N fertilizers levels on grain yield on both seasons, while a significant effect on straw yield in the first season only but no significant effect on straw yield on 2<sup>nd</sup> season. Treatment of fahlberseem with recommended dose from nitrogen fertilizer (70kg.N fed<sup>-1</sup>) had given a best values from grain yield ardb.fed<sup>-1</sup> ( 25.28 and 26.64) ardb.fed<sup>-1</sup> with relative increments of (37.54%) compared with preceding rice-wheat rotation and (23.26%) compared with rice-darawa rotation.

These results may be due to the increase in the activity of antioxidants in response to stresses has been previously reported, which both biotic and a biotic stresses are known to induce plants to produce reactive oxygen species [9]. The increase activity of antioxidant enzymes is perhaps a secondary effect of allelochemicals[25]. Species of preceding crops significantly affected wheat yield such as mungbean might help to maximize wheat yield in a crop rotation system [20] wheat grain yield was greater following legumes crop than other preceding crops. The benefits of the legume crops is related to both nitrogen and the effects of complex rotation procedures. The lowest yield was obtained when wheat was planted after paddy rice [31].

Also, these findings were well supported by many workers like [3], [10] and [34], who found that further increase in biological yield of cereal after legume crop rather than after continuous preceding cereal crops.

{35}, {37} and {17}, studied the effect of preceding crops and nutrient management on growth, productivity and quality of wheat. They indicated that growing legume crop as the preceding crop resulted significant higher grain and straw yields of wheat than preceding maize crop.

**Table 9: nitrogen , P, K and Protein concentration (%) of wheat grain as affected by the remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016 /2017 and 2017/2018 seasons.**

| Treatments                       | N%              |                 | P%              |                 | K%              |                 | Protein%        |                 |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                  | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| <b>A-preceding crops</b>         |                 |                 |                 |                 |                 |                 |                 |                 |
| Rice(fallow)                     | 1.25            | 1.31            | 0.22            | 0.21            | 0.43            | 0.44            | 7.14            | 7.47            |
| Drawa                            | 1.33            | 1.44            | 0.24            | 0.26            | 0.46            | 0.46            | 7.60            | 8.11            |
| Fahlberseem                      | 1.55            | 1.59            | 0.28            | 0.30            | 0.50            | 0.51            | 8.82            | 9.01            |
| <b>L.S.D at 0.05</b>             | <b>0.0514</b>   | <b>0.0143</b>   | <b>0.00912</b>  | <b>0.0019</b>   | <b>0.0033</b>   | <b>0.0041</b>   | <b>0.2835</b>   | <b>1.376</b>    |
| <b>F.T.</b>                      | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       |
| <b>B- N-fertilization levels</b> |                 |                 |                 |                 |                 |                 |                 |                 |
| Control                          | 1.16            | 1.24            | 0.21            | 0.23            | 0.33            | 0.34            | 6.61            | 7.03            |
| 35                               | 1.36            | 1.41            | 0.26            | 0.25            | 0.49            | 0.49            | 7.79            | 8.04            |
| 70                               | 1.61            | 1.69            | 0.29            | 0.30            | 0.57            | 0.58            | 9.16            | 9.63            |
| <b>L.S.D at 0.05</b>             | <b>0.0327</b>   | <b>0.0293</b>   | <b>0.0050</b>   | <b>0.0033</b>   | <b>0.0078</b>   | <b>0.004</b>    | <b>0.1863</b>   | <b>1.1702</b>   |
| <b>F.T.</b>                      | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       |

Found data in Table 9 observed that wheat grains N, P, K and protein concentration have been affected by treatments of previous crops and mineral nitrogen fertilizer rates. With respect of the first and second seasons; the highest values were obtained when wheat followed fahlberseem compared with the other

preceding crops which recorded the height values (1.55, 1.59); (0.28, 0.30); (0.50, 0.51) and (8.82, 9.01) for N, P, K and protein concentration, respectively.

On the other hand the highest values of the same parameters were realized by apply the treatment of recommended dose from N fertililzer (70 kg N.fed<sup>-1</sup>) (1.61, 0.29, 0.57 and 9.16) for N, P, K and protein% in the first season and (1.69, 0.30, 0.58 and 9.63) in the second one.

The second season gave better results than the first: interpret this data

**Table 10: nitrogen, P, K and Protein concentration (%) of wheat grain as affected by the interaction between remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016/2017-and 2017/2018 seasons.**

| Treatments    |      | N%              |                 | P%              |                 | K%              |                 | Protein%        |                 |
|---------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|               |      | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| Rice(fallow)  | Zero | 1.07            | 1.14            | 0.19            | 0.19            | 0.29            | 0.31            | 6.09            | 6.49            |
|               | 35   | 1.24            | 1.32            | 0.23            | 0.23            | 0.46            | 0.45            | 7.08            | 5.64            |
|               | 70   | 1.44            | 1.48            | 0.26            | 0.27            | 0.53            | 0.55            | 8.22            | 8.43            |
| Darawa        | Zero | 1.15            | 1.26            | 0.21            | 0.21            | 0.33            | 0.34            | 6.59            | 7.16            |
|               | 35   | 1.29            | 1.34            | 0.24            | 0.25            | 0.48            | 0.48            | 7.41            | 7.39            |
|               | 70   | 1.54            | 1.71            | 0.28            | 0.29            | 0.56            | 0.57            | 8.79            | 9.76            |
| Fahlberseem   | Zero | 1.25            | 1.32            | 0.22            | 0.24            | 0.36            | 0.37            | 7.12            | 7.42            |
|               | 35   | 1.55            | 1.57            | 0.31            | 0.32            | 0.54            | 0.54            | 8.87            | 8.94            |
|               | 70   | 1.83            | 1.87            | 0.32            | 0.34            | 0.62            | 0.62            | 10.46           | 10.65           |
| L.S.D at 0.05 |      | 0.0567          | 0.0508          | 0.0567          | 0.0034          | 0.0567          | 0.0057          | 0.3227          | -               |
| F.T.          |      | **              | **              | **              | **              | **              | **              | **              | N.S             |

Data presented in Table 10 reveal that fahlberseem as preceding crop treatments with recommended dose of N fertilizer (70 kg.N.fed<sup>-1</sup>) produced the highest

percentages of (N, P & K ) in wheat grain( 1.83, 0.325 & 0.620) and ( 1.87, 0.342 & 0.627) in the first and second seasons respectively. On the other hand, preceding crops with rates of N fertilizer treatments significantly affected protein % in the first season only. The highest value was observed with clover treatments + 70 kg N.fed<sup>-1</sup>(10.46%) While protein had no significant affected in the second season.

These results agree with [21] and [14]. They studied the effect of preceding crops on protein content in winter wheat. They demonstrated that, protein content in wheat grain was to a greater extent determined by preceding legume crops rather than organic manure. These results may be due to C/N ratio of clover residue compared with other preceding crops. C:N ratio in cereal crops (rice and maize) is widely rather than C:N ratio in legumes which is narrow. Microorganisms such as bacteria need N to live and in decomposition process Soit can break down legume residues in short time compared with cereal residues and improve available N and other minerals in soil which allow to uptake by root plants which effect on growth yield but wider C:N ratio in cereal residuals (roots) leading to immobilization of soil N.

**Table 11:** nitrogen, P, K and Protein concentration (%) of wheat straw (Triticum sp.) as affected by the remnants of the preceding crops, mineral nitrogen fertilizer levels during 2016 /2017 and 2017 / 2018 seasons.

The data obtained from Table 11 show that a significant effect of residual crops (maize & clover) on N, P and K and protein concentration of wheat straw

| Treatments                       | N%              |                 | P%              |                 | K%              |                 | Protein%        |                 |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                  | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| <b>A-preceding crops</b>         |                 |                 |                 |                 |                 |                 |                 |                 |
| <b>Rice(fallow)</b>              | 0.41            | 0.42            | 0.076           | 0.078           | 1.438           | 1.437           | 2.328           | 2.399           |
| <b>Drawa</b>                     | 0.47            | 0.48            | 0.081           | 0.084           | 1.488           | 1.489           | 2.652           | 2.787           |
| <b>Fahlberseem</b>               | 0.52            | 0.53            | 0.092           | 0.096           | 1.448           | 1.455           | 2.977           | 3.024           |
| <b>L.S.D at 0.05</b>             | <b>0.0088</b>   | <b>0.0037</b>   | <b>0.0047</b>   | <b>0.0029</b>   | <b>0.0074</b>   | <b>0.0025</b>   | <b>0.0496</b>   | <b>0.1365</b>   |
| <b>F.T.</b>                      | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       |
| <b>B- N-fertilization levels</b> |                 |                 |                 |                 |                 |                 |                 |                 |
| <b>Control</b>                   | 0.38            | 0.38            | 0.068           | 0.072           | 1.298           | 1.298           | 2.131           | 2.193           |
| <b>35</b>                        | 0.47            | 0.48            | 0.084           | 0.085           | 1.493           | 1.496           | 2.657           | 2.775           |
| <b>70</b>                        | 0.56            | 0.57            | 0.096           | 0.101           | 1.581           | 1.587           | 3.170           | 3.242           |
| <b>L.S.D at 0.05</b>             | <b>0.0081</b>   | <b>0.0019</b>   | <b>0.0057</b>   | <b>0.0014</b>   | <b>0.0103</b>   | <b>0.0030</b>   | <b>0.044</b>    | <b>0.1145</b>   |
| <b>F.T.</b>                      | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       | <b>**</b>       |

in both seasons. The highest values were obtained with residual effect of fahlberseem on N, P, K and protein% (0.52, 0.092, 1.44 and 2.97%) and (0.53, 0.096, 1.455 and 3.02%) in first and second season respectively. High significant effect of mineral nitrogen fertilizer treatments on N, P, K and protein concentration in wheat straw in both seasons. Rate of 70 kg N.fed-1 (RD) gave better results in N(0.56 & 0.53 %), P (0.096 & 0.101%), K (1.58 & 1.58%) and protein (3.17 & 3.24%) in the first and second season respectively compared with the control treatment.

**Table 12: nitrogen, P, K and Protein concentration (%) of wheat straw as affected by the interaction between remnants of the preceding crops with mineral nitrogen fertilizer levels during 2016 /2017 and 2017 / 2018 seasons.**

Interaction between root residual of maize and fahlberseem with rates of mineral nitrogen fertilizer significantly affected N, P, K and protein

| Treatments    |      | N%              |                 | P%              |                 | K%              |                 | Protein%        |                 |
|---------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|               |      | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| Rice(fallow)  | Zero | 0.31            | 0.32            | 0.060           | 0.063           | 1.24            | 1.29            | 1.77            | 1.83            |
|               | 35   | 0.43            | 0.44            | 0.075           | 0.077           | 1.51            | 1.51            | 2.45            | 2.52            |
|               | 70   | 0.49            | 0.50            | 0.091           | 0.093           | 1.56            | 1.55            | 2.77            | 2.85            |
| Drawa         | Zero | 0.40            | 0.41            | 0.065           | 0.071           | 1.38            | 1.36            | 2.23            | 2.35            |
|               | 35   | 0.46            | 0.46            | 0.082           | 0.085           | 1.52            | 1.52            | 2.61            | 2.81            |
|               | 70   | 0.55            | 0.56            | 0.095           | 0.098           | 1.57            | 1.58            | 3.12            | 3.20            |
| Fahlberseem   | Zero | 0.42            | 0.42            | 0.077           | 0.082           | 1.28            | 1.28            | 2.40            | 2.40            |
|               | 35   | 0.51            | 0.53            | 0.095           | 0.093           | 1.45            | 1.46            | 2.91            | 3.00            |
|               | 70   | 0.64            | 0.64            | 0.103           | 0.113           | 1.62            | 1.63            | 3.62            | 3.67            |
| L.S.D at 0.05 |      | 0.0141          | 0.0034          | -               | 0.0025          | 0.0179          | 0.0052          | 0.0769          | 0.198           |
| F.T.          |      | **              | **              | N.S             | *               | **              | **              | **              | *               |

concentration where they increased P in the second season only (0.113%) While, P had no significantly affected in the first season . N, K and protein % in both season (Table 13) (fahl berseem+70 kg N.fed<sup>-1</sup>) had the highest values (0.64, 1.62and 3.62) and (0.64, 1.63 and 3.67) in first and second season respectively, but the lowest values (0.31, 1.24 and 1.77) and (0.32, 1.29 and 1.83) were detected with control treatment in first and second season respectively. These results may be due to legumes promoted the growth of larger, more metabolically active microbial population which support greater nutrient mineralization and overall improvement of soil fertility, compared with continuous rice and maize.

Also, C:N ratio of rice residues more than 90:1 and maize was 88:1 which causes decompose slowly in soil and therefore reduces N supply for the subsequent crop. The decomposition rate is expected to be higher for rice and

maze crops than for legumes which have high C:N ratio and high lignin contents and decompose slowly.

These results agree with [2] who studied the effect of preceding rice and mineral fertilization by phosphorus and Zinc fertilizers with recommended dose from N and K on wheat straw yield under rice-wheat system, they observed that, the interaction between preceding and mineral fertilizers increase chemical composition of wheat straw yield. But these results less than legumes-wheat rotation.

**Table 13: N-uptake and N utilization rate % of wheat as affected by remnants of the preceding crops with mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

| Treatments | N-uptake kg.fed <sup>-1</sup> |                 | N-Utilization rate% |                 |
|------------|-------------------------------|-----------------|---------------------|-----------------|
|            | 1 <sup>st</sup>               | 2 <sup>nd</sup> | 1 <sup>st</sup>     | 2 <sup>nd</sup> |

| <b>A-preceding crops</b>         |               |               |                |               |
|----------------------------------|---------------|---------------|----------------|---------------|
| <b>Rice (fallow)</b>             | 32.24         | 33.67         | 23.50          | 24.52         |
| <b>Drawa</b>                     | 39.39         | 44.75         | 27.87          | 31.77         |
| <b>Fahlberseem</b>               | 53.64         | 58.23         | 39.66          | 42.83         |
| <b>L.S.D at 0.05</b>             | <b>1.5443</b> | <b>0.4131</b> | <b>0.87118</b> | <b>0.5466</b> |
| <b>F.T.</b>                      | <b>**</b>     | <b>**</b>     | <b>**</b>      | <b>**</b>     |
| <b>B- N-fertilization levels</b> |               |               |                |               |
| <b>0</b>                         | 32.80         | 36.05         | 00.00          | 00.00         |
| <b>35</b>                        | 40.17         | 43.22         | 39.23          | 42.19         |
| <b>70</b>                        | 52.31         | 57.38         | 51.81          | 56.93         |
| <b>L.S.D at 0.05</b>             | <b>0.96</b>   | <b>0.87</b>   | <b>0.93</b>    | <b>0.47</b>   |
| <b>F.T.</b>                      | <b>**</b>     | <b>**</b>     | <b>**</b>      | <b>**</b>     |

Generally, data in Table 13 show the values of N-uptake and values of N utilization rate % in the first and second seasons as affected by preceding crops and rates of mineral nitrogen fertilizer. The data indicated that residual of crops had a significant effect of N-uptake  $\text{kg.fed}^{-1}$ . Treatment of clover had given a best value of N-uptake  $\text{Kg.fed}^{-1}$  (53.64 & 58.23) in the first and second season respectively. The highest values of N utilization rate % were obtained with fahlberseem, compared with maize treatment.

Table 13 show that, the difference between rates of nitrogen fertilizer on N-uptake and values of N utilization rate% were significant. The control treatment had the lowest mean of N-uptake while, treatment of recommended dose gave the highest average of this parameters. Also, recommended dose from mineral nitrogen was gave the highest values of N utilization rate in both seasons.

**Table 14: N-uptake and N utilization rate % of wheat as affected by the interaction between remnants of the preceding crops with mineral nitrogen fertilizer levels during 2016/2017 and 2017/2018 seasons.**

| Treatments    |      | N-uptake kg.fed <sup>-1</sup> |                 | N-Utilization rate % |                 |
|---------------|------|-------------------------------|-----------------|----------------------|-----------------|
|               |      | 1 <sup>st</sup>               | 2 <sup>nd</sup> | 1 <sup>st</sup>      | 2 <sup>nd</sup> |
| Rice (fallow) | Zero | 25.03                         | 26.33           | 00.00                | 00.00           |
|               | 35   | 31.89                         | 33.76           | 31.17                | 33.01           |
|               | 70   | 39                            | 40.93           | 39.33                | 40.55           |
| Darawa        | Zero | 33.15                         | 37.51           | 00.00                | 00.00           |
|               | 35   | 37.55                         | 40.27           | 36.60                | 39.2            |
|               | 70   | 47.48                         | 56.47           | 47.01                | 56.11           |
| Fahlbersem    | Zero | 40.22                         | 44.31           | 00.00                | 00.00           |
|               | 35   | 51.07                         | 55.63           | 49.92                | 54.37           |
|               | 70   | 69.65                         | 74.76           | 69.07                | 74.13           |
| L.S.D at 0.05 |      | 1.6766                        | 1.508           | 1.61647              | 0.82135         |
| F.T.          |      | **                            | **              | **                   | **              |

Data in Table 14 present the effects of the interaction between preceding crops and rates of mineral nitrogen fertilizer on N-uptake  $\text{kg.fed}^{-1}$  and N utilization rate values. Data show that a significant effect was detected, where the control treatment had the lowest values while fahlberseem with  $70 \text{ Kg N.fed}^{-1}$  gave the highest values of N uptake. On the other hand, data show that The interaction between fahlberseem recommended dose gave the highest values of N utilization rate in both seasons.

Nitrogen efficiency indices significantly affected by crop rotation and N fertilizer rate [19]. Nitrogen utilization efficiency of wheat affected by preceding crop, application rate of nitrogen and crop residues. N-uptake, N Utilization efficiency in wheat Were significantly affected by preceding crop. Also fertilizer N rate applied on preceding crops [27].

**Table 15: nitrogen, P, K  $\text{mg.kg}^{-1}$  and O.M% on soil after harvesting as affected by remnants of the preceding crops with mineral nitrogen fertilizer levels during 2016 /2017 and 2017 / 2018 seasons.**

| Treatments           | N $\text{mg.kg}^{-1}$ |                 | P $\text{mg.kg}^{-1}$ |                 | K $\text{mg.kg}^{-1}$ |                 | O.M %           |                 |
|----------------------|-----------------------|-----------------|-----------------------|-----------------|-----------------------|-----------------|-----------------|-----------------|
|                      | 1 <sup>st</sup>       | 2 <sup>nd</sup> | 1 <sup>st</sup>       | 2 <sup>nd</sup> | 1 <sup>st</sup>       | 2 <sup>nd</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> |
| <b>A-crops</b>       |                       |                 |                       |                 |                       |                 |                 |                 |
| Rice                 | 28.48                 | 29.24           | 14.36                 | 16.25           | 234.33                | 235.85          | 1.33            | 1.38            |
| Maize                | 30.21                 | 31.92           | 16.16                 | 18.45           | 243.88                | 249.68          | 1.39            | 1.43            |
| FahlBerseem          | 34.62                 | 37.93           | 22.65                 | 25.47           | 387.44                | 394.66          | 1.51            | 1.55            |
| <b>L.S.D at 0.05</b> | <b>0.142</b>          | <b>1.07</b>     | <b>0.51</b>           | <b>0.38</b>     | <b>4.18</b>           | <b>2.27</b>     | <b>0.009</b>    | <b>0.010</b>    |
| <b>F.T.</b>          | <b>**</b>             | <b>**</b>       | <b>**</b>             | <b>**</b>       | <b>**</b>             | <b>**</b>       | <b>**</b>       | <b>**</b>       |

| <b>B- N-fertilization levels</b> |             |             |             |             |             |             |              |              |
|----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|
| 0                                | 28.01       | 30.47       | 16.56       | 19.23       | 269.66      | 274.32      | 1.35         | 1.38         |
| 35                               | 30.84       | 32.88       | 17.86       | 19.77       | 288.33      | 291.55      | 1.39         | 1.43         |
| 70                               | 34.46       | 35.74       | 18.75       | 21.17       | 307.66      | 314.33      | 1.49         | 1.55         |
| <b>L.S.D at 0.05</b>             | <b>0.84</b> | <b>1.03</b> | <b>0.40</b> | <b>0.32</b> | <b>2.87</b> | <b>2.40</b> | <b>0.011</b> | <b>0.011</b> |
| <b>F.T.</b>                      | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>   | <b>**</b>    | <b>**</b>    |

Table 15 represents the effect of previous crops and mineral nitrogen fertilizer on available N, P, K and O.M% in the soil after wheat harvesting. Significant effects of all parameters (available N, P, K and O.M%) in the soil were detected. The highest values of available N, P, K and O.M% were recorded with preceding FahlBerseem treatment. Table 16 shows that differences between the rates of nitrogen fertilizer on available N, P, K and O.M% were highly significant, where the control treatment had the lowest values while recommended dose gave the highest values of available N, P, K and O.M%.

**Table 16: nitrogen, P, K mg.kg<sup>-1</sup> and O.M% on soil after harvesting as affected by the interaction between remnants of the preceding crops with mineral nitrogen fertilizer levels during 2016 /2017 and 2017 / 2018 seasons.**

| <b>Treatments</b>    |             | <b>N mg.kg<sup>-1</sup></b> |                       | <b>P mg.kg<sup>-1</sup></b> |                       | <b>K mg.kg<sup>-1</sup></b> |                       | <b>O.M %</b>          |                       |
|----------------------|-------------|-----------------------------|-----------------------|-----------------------------|-----------------------|-----------------------------|-----------------------|-----------------------|-----------------------|
|                      |             | <b>1<sup>st</sup></b>       | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>       | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b>       | <b>2<sup>nd</sup></b> | <b>1<sup>st</sup></b> | <b>2<sup>nd</sup></b> |
| <b>Rice (fallow)</b> | <b>Zero</b> | 25.1                        | 27.60                 | 12.76                       | 14.10                 | 219                         | 222.56                | 1.25                  | 1.30                  |
|                      | <b>35</b>   | 28.36                       | 29.90                 | 14.73                       | 16.50                 | 235                         | 234                   | 1.29                  | 1.33                  |
|                      | <b>70</b>   | 32                          | 30.23                 | 15.60                       | 18.16                 | 249                         | 251                   | 1.45                  | 1.50                  |
| <b>Drawa</b>         | <b>Zero</b> | 26.93                       | 29.06                 | 15.50                       | 17.23                 | 227.66                      | 229.4                 | 1.31                  | 1.35                  |
|                      | <b>35</b>   | 29.03                       | 31.26                 | 16.23                       | 18.26                 | 244.33                      | 249                   | 1.37                  | 1.41                  |
|                      | <b>70</b>   | 34.66                       | 41.56                 | 16.76                       | 19.86                 | 259.66                      | 270.6                 | 1.51                  | 1.55                  |
| <b>FahlBerseem</b>   | <b>Zero</b> | 32                          | 34.73                 | 21.43                       | 23.73                 | 362.33                      | 371                   | 1.49                  | 1.51                  |
|                      | <b>35</b>   | 35.13                       | 37.50                 | 22.63                       | 25.60                 | 385.66                      | 391.6                 | 1.52                  | 1.56                  |

|                      |           |             |             |             |             |             |             |              |              |
|----------------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|
|                      | <b>70</b> | 36.73       | 41.56       | 23.90       | 27.10       | 414.33      | 421.3       | 1.53         | 1.60         |
| <b>L.S.D at 0.05</b> |           | <b>1.46</b> | <b>1.79</b> | <b>0.70</b> | <b>0.55</b> | <b>4.98</b> | <b>4.16</b> | <b>0.019</b> | <b>0.019</b> |
| <b>F.T</b>           |           | *           | *           | *           | **          | **          | **          | **           | **           |

Table 16 represents the effect of interaction between remnants of the preceding crops with mineral nitrogen fertilizer on available N, P, K and O.M% in the soil after wheat harvesting. Significant effects of (available N) and a high significant effects of another parameters (available P, K and O.M%) in the soil were detected. where the lowest values were recorded due to control treatments under preceding Rice-wheat treatment, while treatment with (70 kg N.fed<sup>-1</sup>) gave better results under preceding FahlBerseem in available N (36.73 and 41.56 mg kg<sup>-1</sup>) in the first and second season, respectively. The highest values of available P (23.90 and 27.10 mg kg<sup>-1</sup>) in the first and second season, respectively. The highest values of available K (414.33 and 421.3 mg kg<sup>-1</sup>) in the first and second season, respectively and the highest values of O.M% (1.53 and 1.60%) in the first and second season, respectively .

These results agree with [34].who found that the organic carbon content and available N, P and K in soil after harvest of wheat crop were significantly higher under preceding lower crop.

[36]studied the effect of preceding crops and nitrogen rates on soil organic carbon and total soil nitrogen content. They indicated that organic carbon and soil nitrogen content after legumes crops were found higher than after summer maize and follow.

[21]studied the effect of preceding crops and green manure on the fertility of clay loam soil. They showed that, the highest content of total N, humus, available P and K in the soil after lucerne as a preceding crop when green manure had been applied.

**These results may be due to** organic carbon content of soil under legume was probably due to addition of biomass of narrower C:N ration by

legumes. Higher soil N content after legumes can be explained by mechanism of biological nitrogen fixation occurring in legumes. Also microorganisms produced organic acids which decrease soil pH and increase availability from P and K.

#### 4. CONCLUSIONS

Cereal winter crops can be sown after preceding legume crops rather than summer cereal crops. We can sow fahlberseem crop as a forage to animals after cereal crop (rice) and before sowing wheat crop to improve soil properties and its availability of the essential elements and consider additional revenue to farmer. Fahlberseem had been sown in the end of August month after rice crop to produce approximately 20 ton fresh forage  $\text{fed}^{-1}$  (~ 9 ton dry grass  $\text{fed}^{-1}$ ) which provides farmers with (~ 9 thousands EL) in 88 days only.

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