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# Modified Polyurethane Foam with Rice Husks as a Retention Polymer, It's Effect on Plant Growth and Productivity in Abu Kurab 3 Wheat

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**Abstract**

This study was carried out to prepare modified polyurethane foam with rice husks, which was prepared by reacting liquid isocyanate with liquid blended polyols (ratio of 1:1 in volume) where the particles of the rice husks were around 70 micrometer were added in a ratio (1/3) to the liquid reaction to get the modified foam. The ratio of absorbed water of modified polyurethane was studied, the decreases in the absorption of water could be referred to the cross linking, in addition to that the particles of the rice husks fills the spaces between the chains inside the structure of the polymer. The researchers also studied the effect of the modified foam on the properties of wheat such as; growth, decimation productivity, and spike height, Chibayish marshes water was used in irrigation. The increases in the height of polyurethane foam from 1 cm to 3 cm will decreased the percentage of germination to zero, because it will prevent the longitudinal growth of superficial roots of wheat. The decimation of wheat was investigated for the period (from October 1st 2019 to May 1st 2020), and it was (4.1 gm/100 seeds) comparing with control (3.7gm/100 seeds) and the productivity was also increased to 4.5 gm/100 seeds. It was also concluded that using the marshes water in irrigation will increased the seeds of each spike by almost 20%.

Keywords: polyurethane, rice husks, wheat, productivity, decimation

## 1. Introduction

Polymeric foams can be found virtually everywhere due to their advantageous properties compared with counterparts materials "as explained by [1, 2]". Possibly the most important class of polymeric foams are polyurethane foams (PUFs), as their low density and thermal conductivity combined with their interesting mechanical properties make them excellent for many applications " as it was depicted by [1-3]".

It is well known that the application of polyurethane material is determined by two important parameters which are density and rigidity of polyurethane material "as it was discussed elsewhere by [4, 5]". Major uses of polyurethane material are in making of plastics, cushions, foams, rubber goods, synthetic leathers and fibers. They are also used in furniture industry, construction, and shoe industry, medicinal and agricultural applications "as explained by [6-10]".

More studies have been carried out on the uses of polyurethane foams. Wide of these studies focused on the effect of local fillers; rice husk and corn cob on some physico-mechanical properties flexible polyether foam has been investigated "as mentioned by [11, 12]". They demonstrated that the mechanical properties of the filled foams improved significantly "as reported by [13]". The particle sizes and chemical structure of the vegetable filler played significant role on the mechanical properties of the biocomposite fabricated "as it was concluded by [14]". The Interest in natural fiber reinforced composite materials is growing rapidly since biocomposite offer a lighter, stiffer, non-toxic, non-abrasive and biodegradable

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nature.

One of these fillers is rice husk which is consider as one of the major agricultural residues produced as a by-product during rice processing. Usually it has been a problem for rice farmers due to its resistance to decomposition in the ground, difficult digestion and low nutritional value for animals "as it was discussed by [15, 16]". According to Marti-Ferrer [16, 17] the lignin and hemicellulose contents of rice husk are lower than wood whereas the cellulose content is similar. For this reason Rice Husk Flour can be processed at higher temperatures than wood. many researchers use rice husk as the filler to prepare polymer complex "as reported by [17, 18]". "Rozman [19]" has studied the mechanical and physical properties of PU–RH composites. Therefore, the use of rice husk in the manufacture of polymer composites is attracting much attention. It is one of the most widely available agricultural wastes in many rice producing countries of the world. They are the hard protecting coverings of grains of rice and removed from rice seed as a by-product during the milling process. It is essentially free as waste product from agriculture sector and forest residues "as reported by [16, 18, and 20]".

In this article we focus on preparing polyurethane foam modified with rice husk and its use as both a retention polymer and a filter where it has an effect on wheat properties.

## 2. Experimental

Rice husks have been brought from Rice farms in Najaf governorate in Iraq. After that the rice husk was watery cleaned and dried. The dried rice husks were then grinded in to small particles as shown in figure (1) which shows the rice husk before and after the grinding. In order to obtain a specified particle volume equal or less than 600 micrometers the obtained rice husk powder deal with 600 micrometers sieve. Polyurethane foam is made by reacting diisocyanates (part B) and polyols (part A). A mixing ratio of 1:1 (50:50) was used which means that part A was equal to part B. The synthesis of rice husk powder (600 micrometer) filled polyurethane foam was done by mixing 160 gram of part A and 140 gram of part B in a container and adding 100 gram of rice husks power in to the mixing container and mix the mixture for 2 minutes. At the end of mixing process, the mixture will rise forming the upper layer leaving the resulted foam for one day and then cut in to coaxial piece like shown in figure (2). The modified foam was cut in to a coaxial shape with (2.5 cm and 5 cm) diameters. Each diameter of these pieces was prepared at three different heights (1, 2. 3 cm).

All tests were made in one of the agricultural land in the district of Qurna/Basra/south of Iraq during the agricultural season which was 2019/2020 and the wheat cultivar Abu Kurab 3 was also used. The irrigation water that was used in this search is the Chibayish marshes water which has a certain properties that were listed in table (3). The agricultural matrix was made by the distribution of five replicates for each longitudinal meter as shown in figure (3). Five grains of wheat were the indiscriminately distributed to each repeater; the irrigation period in this experiment was three weeks. The following equation was used to obtain the results:

1- The percentage of germination the number of seeds germinated from numerical total was calculated according to the following equation "as described by [21]".

$$\text{The Almaah percentage of germination} = \frac{\text{Number of growth seeds}}{\text{The total number of seeds}} \text{ X } 100$$

2- Production plants (productivity of the plant) has been calculated for each transaction through a hundred grain weight "as depicted by [22]".


Figure 1: The rice husk before and after grinding

Figure 2: The coaxial shape of rice husk filled polyurethane foam

Figure 3: The Distribution of Replicates for Each Longitudinal Meter

Table 1: Some Physical and Chemical Properties of Chibayish Marshes Water

| $HCO_3$ ppm | $CO_3$ ppm | Cl ppm | TDS ppm (wheat) | E.C. ms/cm (wheat) | pH |
|---|---|---|---|---|---|
| 159 | 15 | 877 | 3390 | 4.75 | 8.1 |

## 3. Results and Discussion

The water absorption capacity was calculated from measured weight using the equation "as discussed by Mužíková et al., [28]":

$$m_W = \frac{(m - m_d)}{m_d}$$

As a weight of the wet specimen m minus the weight of dry specimen $m_d$ and then it was divided by the weight of the dry specimen $m_d$ (the weight of the specimen in the beginning of the test) and it was multiplied by 100 to transform it to percentage of weight "as discussed by Mužíková et al., [28]".

Figure (2) shows the changes made to the weight of modified specimen as a function of dipping time in water. It is obvious that the increment with weight is less than expected since the saturation ratio of absorption reached at 60 minutes. The last result is due to both the cross linking density which prevent the deep absorption of water molecules in to the foam matrix and also due to rice husks particles distribution which let no space between the chains of the polymer matrix. It is necessary to recommend using another kind of dust that has a high absorption ratio towards water like saw dust. Rice husk can absorb water ranging from 5% to 16% of unit weight while saw dust can absorb water ranging from "as discussed by [29, 30]".

The obtained results of the percentage of germination and the number of grown seeds during November 2019 are included in tables (2, 3, and 4). The first result we obtained is that the increase of polyurethane foam height from 1 cm to 3 cm decreases the percentage of germination under marshes water irrigation conditions to reach zero at 3 cm. It is obvious that the heights of 1 cm and 2 cm have the same percentage of germination. Four days later, the percentage of germination is doubled compared to a slight increase in both 3 cm and control ones as included in table (3). At the end of November, an obvious increase in the percentage of germination in the control one is observed reaching 80% which is much higher than that of 3 cm. Clearly the percentage of germination is a function of grown seeds.

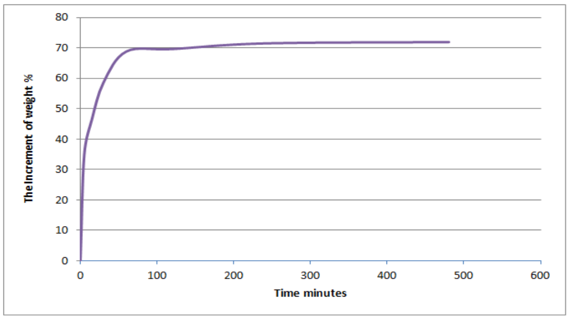


Figure 2: The Increment of Weight with Time of Dipping in Water

The above results can be explained in terms of the superficial roots of wheat where the much height of the polyurethane foam prevents or hampers those roots from the longitudinal growth. In a similar way, two less effects appeared: the first is the less root growth and the second is the changes in the distribution of plant roots. Those two reasons produced weak and less productive wheat.

The wheat decimation is also studied for the period (from November $17^{th}$ to May $1^{st}$) where all the obtained results are included in tables (5, 6, 7 and 8) respectively. It is obvious that the decimation percentage increases during this period which is a direct sign of the decreasing number of grown seeds.

A noticeable decimation appears on those wheat plants surrounded with the polyurethane hollow cylindrical pieces of 2 cm and 3 cm height reaching 100% of decimation while those surrounded with 1 cm polyurethane foam and the control ones have less decimation percentages. Besides the afore-mentioned reasons the above results can be explained in terms of the slight filtering effect against salinity and the less work of the retention agent since the increase of the polyurethane height leads to more deep (vertical) release of water than the side release where the latter which is important for the plant growth and the root distribution through the surface soil is limited.

Table 2: The Seed Growth as a Function of Polyurethane Foam Length (November 15, 2019)

| **Sample** | **R1 Growth** | **R2 Growth** | **R3 Growth** | **R4 Growth** | **R5 Growth** | **Growth ratio** |
|---|---|---|---|---|---|---|
| 1 cm | Yes | No | No | Yes | No | 2/5 |
| 2 cm | Yes | No | No | Yes | No | 2/5 |
| 3 cm | No | No | No | No | No | Zero |
| Control | No | No | No | No | No | Zero |

Table 3: The Seed Growth as a Function of Polyurethane Foam Length (November 19, 2019)

| **Sample** | **R1 Growth** | | **R2 Growth** | | **R3 Growth** | | **R4 Growth** | | **R5 Growth** | | **Growth ratio** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 cm | 4/5 | Yes | Zero | No | 4/5 | yes | 5/5 | Yes | 4/5 | Yes | 4/5 |
| 2 cm | 3/5 | Yes | 2/5 | yes | 1/5 | yes | Zero | No | 3/5 | Yes | 4/5 |
| 3 cm | Zero | No | Zero | No | Zero | No | 2/5 | Yes | Zero | No | 1/5 |
| Control | 5/5 | No | zero | No | Zero | No | Zero | No | 1/5 | Yes | 1/5 |

Table 4: The Seed Growth as a Function of Polyurethane Foam Length (November 30. 2019)

| **Sample** | **R1 Growth** | | **R2 Growth** | | **R3 Growth** | | **R4 Growth** | | **R5 Growth** | | **Growth ratio** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 cm | 4/5 | Yes | 3/5 | Yes | 4/5 | Yes | 3/5 | Yes | 4/5 | Yes | 5/5 |
| 2 cm | 5/5 | Yes | 4/5 | Yes | 3/5 | Yes | 1/5 | yes | 1/5 | Yes | 5/5 |
| 3 cm | 3/5 | yes | Zero | No | Zero | No | 3/5 | no | Zero | No | 1/5 |
| Control | 5/5 | yes | 4/5 | Yes | 5/5 | Yes | Zero | No | 3/5 | Yes | 4/5 |

Table 5: The Seed and Plant Decimation as a Function of Polyurethane Foam Length (November 17, 2019)

| **Sample** | **R1 Decimation** | **R2 Decimation** | **R3 Decimation** | **R4 Decimation** | **R5 Decimation** | **Decimation ratio** |
|---|---|---|---|---|---|---|
| 1 cm | No | No | No | No | No | Zero |
| 2 cm | NO | No | No | No | No | Zero |
| 3 cm | No | No | No | No | No | Zero |
| Control | No | No | No | No | No | Zero |

Table 6: The Seed and Plant Decimation as a Function of Polyurethane Foam Length (November 28, 2019)

| **R1 Decimation** | **R2 Decimation** | | **R3 Decimation** | | **R4 Decimation** | | **R5 Decimation** | | **Decimation ratio** | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 cm | 3/5 | 2/5 | 3/5 | 2/5 | 4/5 | 1/5 | 3/5 | 2/5 | 4/5 | 1/5 |
| 2 cm | 3/5 | 2/5 | 3/5 | 2/5 | Zero | 5/5 | 2/5 | 3/5 | 3/5 | 2/5 |
| 3 cm | 3/5 | 2/5 | Zero | 5/5 | 5/5 | Zero | 3/5 | 2/5 | 3/5 | 2/5 |
| Control | 4/5 | 1/5 | 3/5 | 2/5 | 5/5 | Zero | Zero | 5/5 | 5/5 | Zero |

Table 7: The Seed and Plant Decimation as a Function of Polyurethane Foam Length (February 16, 2020)

| **R1 Decimation** | **R2 Decimation** | | **R3 Decimation** | | **R4 Decimation** | | **R5 Decimation** | | **Decimation ratio** | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 cm | 1/5 | 4/5 | Zero | 5/5 | Zero | 5/5 | 1/5 | 4/5 | 2/5 | 3/5 |
| 2 cm | Zero | 5/5 | 1/5 | 4/5 | 3/5 | 2/5 | 5/5 | Zero | 4/5 | 1/5 |
| 3 cm | 2/5 | 3/5 | Zero | 5/5 | Zero | 5/5 | 4/5 | 1/5 | Zero | 5/5 |
| Control | 1/5 | 4/5 | Zero | 5/5 | 5/5 | zero | Zero | 5/5 | 5/5 | Zero |

Table 8: The Seed and Plant Decimation as a Function of Polyurethane Foam Length (May 1st 2020)

| **R1 Decimation** | **R2 Decimation** | | **R3 Decimation** | | **R4 Decimation** | | **R5 Decimation** | | **Decimation ratio** | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 cm | Zero | 5/5 | 1/5 | 4/5 | 3/5 | 2/5 | 2/5 | 3/5 | 4/5 | 1/5 |
| 2 cm | 1/5 | 4/5 | Zero | 5/5 | Zero | 5/5 | Zero | 5/5 | 2/5 | 3/5 |
| 3 cm | Zero | 5/5 | Zero | 5/5 | Zero | 5/5 | 2/5 | 3/5 | Zero | 5/5 |
| Control | Zero | 5/5 | Zero | 5/5 | 3/5 | 2/5 | Zero | 5/5 | 4/5 | 1/5 |

The wheat productivity is also studied where the productivity density of those surrounded with polyurethane foam is found to be (4.1 gm/100 seeds) which is higher than that of control ones (without surrounding polyurethane foam) (3.7 gm/100 seeds). We also compared this result with the productivity of wheat under normal irrigation conditions which is found to be 4.5 gm/100 seeds indicating a higher production portion. The last results is referring to a slight effect of modified foam on wheat productivity, It is necessary here to mention that all the obtained productivity are less than that obtained by other researchers under normal irrigation and different fields “as discussed [31, 32]”.

Finally both the spikes and stems of wheat are less than those of ordinary wheat by 10% and the number of seeds of each spike of ordinary wheat is higher than that irrigated by marsh water by almost 20%.

## 4. Conclusion

The current research reached the following findings:

- No noticeable filtering effect of modified polyurethane foam on the salinity.
- No noticeable retention effect is notice due to high molecular weight of foam.
- Both the cross linking density and rice husks distribution in to the polyurethane foam matrix have a noticeable effect of water absorption ratio.
- Wheat properties like growth, decimation, productivity, spike height and the number of seeds have been improved.
- A slight salinity filtering appears in the used polyurethane foam.

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