

**Discipline- Chemical Science**

Enhancing plant growth, yield and Nutrient use Efficiency of Wheat through Application of Slow Release Fertilizer

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Enhancing crop yield and fertilizer use is being a major challenge to meet the food and nutritional security of ever increasing population and also conserve the natural resources from degradation. Slow release fertilizer not only increase crop yield but also increasing nutrient use efficiency and lower input cost to farmer. Cost of slow release fertilizer is 3-4% higher than ordinary urea. Coated urea has been observed to improve nutrient use efficiency in wheat. Nutrient losses due to leaching, volatilization, immobilization and ground water pollution by nitrates as well as ammonia gas pollution in the air may be reduced through the use of slow release fertilizer. A field experiment was conducted by growing wheat variety LOK-1 on a Vertisol. The treatment were neem coated urea (NCU) and sulphur coated urea (SCU) at 100% and 75% recommended dose, normal urea(100% recommended dose) and absolute control (without any fertilizer). In all the P and K (100% dose) were applied except in control. The results indicated that Nutrient use efficiency viz., agronomic efficiency, utilization efficiency, Potassium use efficiency and phosphorus use efficiency were significantly higher in coated urea applied treatment than that of normal urea applied treatment. The nitrogen use efficiency of SCU, NCU and Normal urea was 65%, 55% and 44% respectively. Further application of coated urea at 75% recommended dose also over performed the normal urea for improving plant growth and wheat crop yield.

Key words- Nutrient use efficiency, Slow release fertilizer, Agronomic efficiency, Plant growth.

Introduction

In 2025 the food grain requirement for India's 1.4 billion people will be about 300 million tonnes (MT). At present more than 75% of the total food grains produced in the nation are of rice and wheat (Subba Rao *et. al.*, 2014). Wheat is India's preeminent, promising crop, and it's also the hub of food security of the global population. Wheat is the 2nd prime cereal crop in India, after rice, both in terms of area and production. In the world, India stands in second in position in the area (12.5%) and production (12.05%) next to China (<http://dwd.dacnet.nic.in>) Majority of agricultural soils in India

have low native fertility (Singh, 2014). During recent years, there has been rapid depletion of soil nutrient reserve which has to be replenished through external supply. However, there is an estimated gap of about ten million tons (MT) between the quantity of nutrients removed by the crop and quantity of nutrient added through fertilizer are observed presently. Nitrogen is a highly mobile in plants because of its deficiency, they are marked by yellowing of leaves, growth reduction (Das and Mandal 2015) stunting of the plant, reduced the grain yield (Grundon, 1987; Wurst *et. al.*, 2010). N deficiency is a major remarkable yield limiting factors for cereals (Shah *et. al.*, 2003), hence nitrogenous fertilizer considered as the greatest source of nitrogen globally. Over the last fifty years, it's contributed to increasing food production per capita approximately 40% (Smil, 2002). Presently 50 % of the population depends on commercial fertilizer inputs for food production (Ladha *et. al.*, 2005).

The excessive use of N fertilizer has raised some global concern, mainly due to the low efficiency of N fertilizer. When N applied into the soil either it's taken up by the plant or lost through the different process like leaching volatilization, denitrification and or its immobilization into unavailable form. Under practical conditions, N use efficiency (NUE) can be defined as the quantity of nutrients taken up by plants and crops into the soil within a certain period of time compared to the quantity of nutrients available in the soil during that same period of time. Hirel *et. al.*, (2007) have estimated nitrogen-use efficiency (NUE) below 33 percent for cereal at the global scale. On an average, the recovery of fertilizer N, especially through chemical fertilizers such as urea, ranges from 20-50% for rice (Prasad *et. al.*, 1998; Ganga *et. al.*, 2012). Increasing nitrogen-use efficiency (NUE) and decreasing nitrogen fertilizer rates can markedly protect the environment. Furthermore, there is a decline in crop production globally per unit of nitrogen (N) applied. Under this situation, need to increase per unit area crop production through the use of proper fertilizer (especially nitrogen) management exercise has become essential for modern crop production. New slow release fertilizer, like sulphur, polymer, and neem coated urea be fully evaluated under conditions. Therefore, in the current investigation the efficacy of coated urea in improving crop yield and nutrient use efficiency has been studied in comparison with neem coated, sulphur coated and normal urea.

Materials and Methods

A field experiment was conducted during rabi season of 2017-18 at the research farm, Aditya Biotech lab Raipur C.G., India. The plots were arranged in completely randomized block design with three replication. The representative soil (0-15) from sample each plot were collected before field preparation with the help of tube auger. Soil sample was air dried and sieved through 2mm sieve. The processed soil sample were used for laboratory analysis. The soil of experimental field had (pH 7.78 and EC 0.22dS m^{-1}). Initially, the soil was low in soil organic carbon (Walkley and Black easily oxidizable carbon) (0.50%), available N (100.8kg ha^{-1}), in available P (12.2 kg ha^{-1}) and in available K (235 kg ha^{-1}) respectively

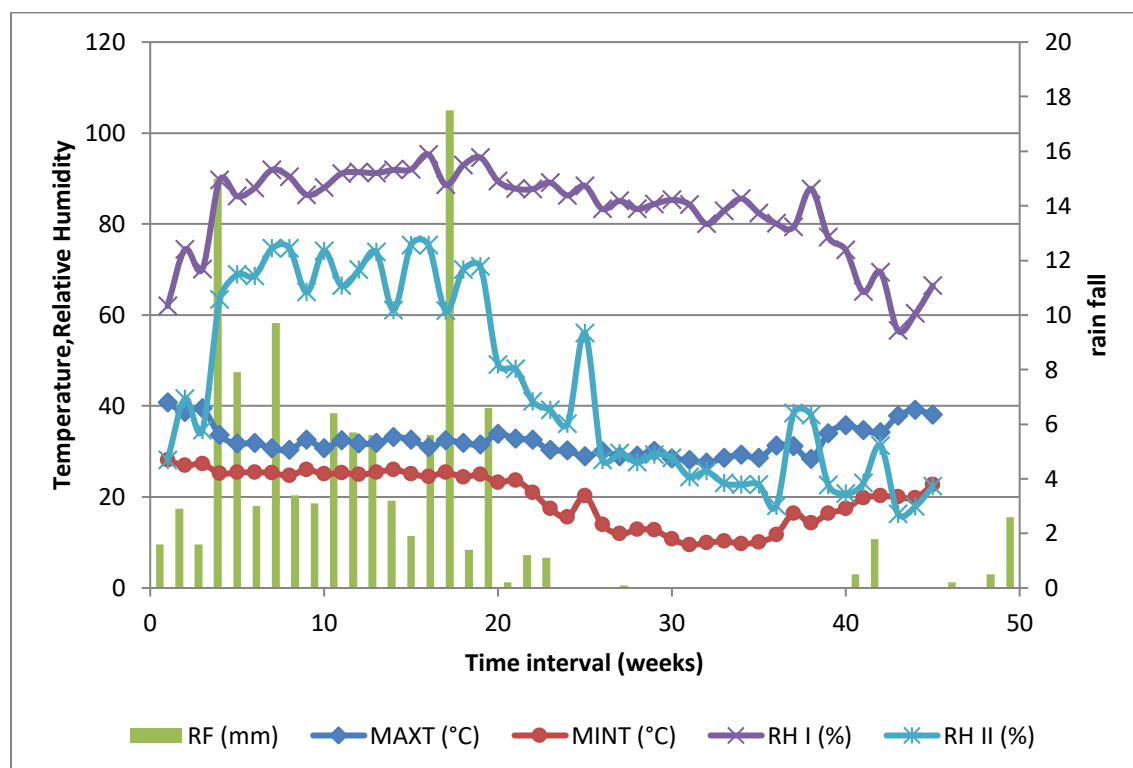


Fig 1: Weekly meteorological data recorded during the crop season (November 2017 to March 2018)

Experimental Details-

Wheat (LOK-1) crop was grown as test crop adopting randomized block design with 3 replications. The size of plots 1m^2 were formed and by using randomization number table the treatments were allotted in each block.

The treatment were neem coated urea, sulphur coated urea and normal urea at 100% & 75% recommended dose and absolute control without any fertilizer. These slow release fertilizer were applied to their respective plots in two splits, one at 30th Day after sowing (DAS) and another at 120th DAS. In all the treatments except control the recommended dose of standard fertilizers was applied as urea, single super phosphate and muriate of potash. Single super phosphate was applied in a single dose basally on 30th DAS and urea and muriate of potash were applied in five equal splits at monthly interval starting from 30th day after sowing. All other routine cultural operation until the harvest of the crop were followed as per the recommendation made in the crop production.

Plant parameters

Plant height was measured by randomly selecting 5 plants in different at 60 and 90 DAS was calculated. The yield attributes like grain yield, straw yield and Nutrient use efficiency also calculated.

Nutrients use efficiency : The nutrient use efficiency viz., agronomic efficiency and utilization efficiency.

$$AE = \frac{\text{Grain yield in fertilized plot (kg ha}^{-1}) - \text{Grain yield in control plot (kg ha}^{-1})}{\text{Quantity of fertilizer nutrient applied (kg ha}^{-1})}$$

Apparent Nutrient Recovery (ANR)

$$\text{ANR} = \frac{\text{Uptake in fertilized plot (kg ha}^{-1}\text{)} - \text{uptake in control plot (kg ha}^{-1}\text{)}}{\text{Quantity of fertilizer nutrient applied (kg ha}^{-1}\text{)}}$$

Statistical analysis

The results were analyzed with Excel software and statistical analysis of data collected through various observations of different parameters of wheat on different dates was carried out in RBD design through software as described by Gomez and Gomez (1984)



Crop 30 DAS



Crop 60 DAS



Crop 90 DAS



Crop at
harvesting

Results and Discussion

Plant Height –

The result of the present investigation showed that the wheat growth parameters such as plant height and no of tillers per plant were significantly influenced by various fertilizer sources and doses at different growth stage (60 DAS, 90 DAS and at harvest stage). Among the different treatments, maximum tillers per plant and plant height were recorded with coated urea applied treatment (SCU and NCU) at varying doses (100% and 75%N along with full doses of P and K) which was superior to other treatments. This can be due to more nitrogen availability in longer run, matching the N demand of crop resulted in better crop growth and more number of tillers. Moreover, the nitrogen release from coated urea eased the nutrient availability by minimizing the nitrogen losses (Jadon 2017). NCU products were extend the N release up to 10 days as compared to prilled urea (Suganya et al. 2009). Number of tillers per plant and plant height increased with the application of coated urea was also reported by Nash et al. (201); Rajani and Sen (2017).

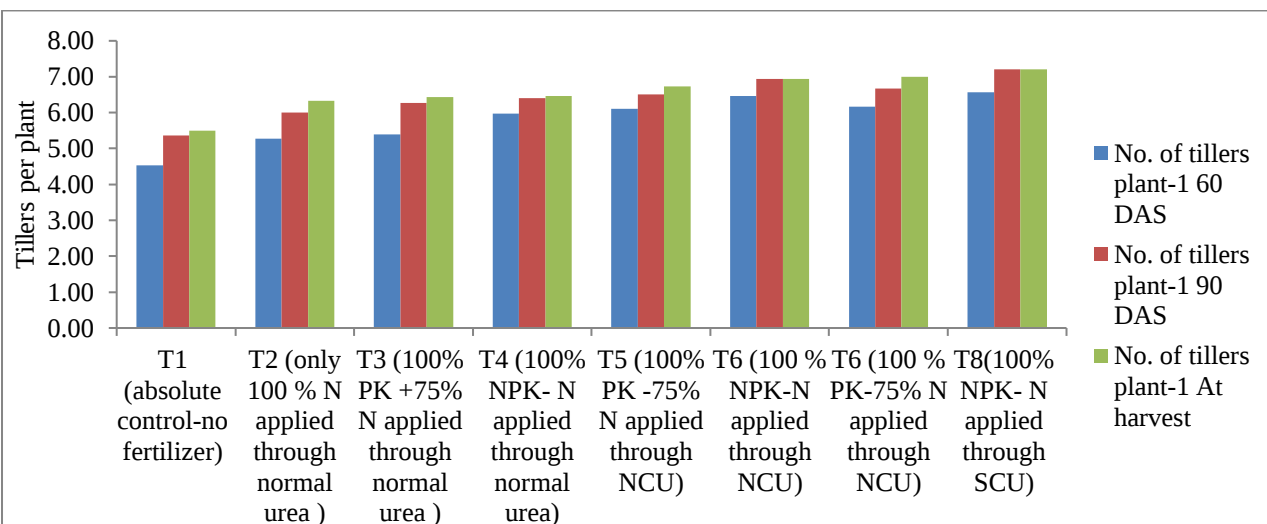


Fig 2. No. of tillers influenced by slow release fertilizer of wheat crop

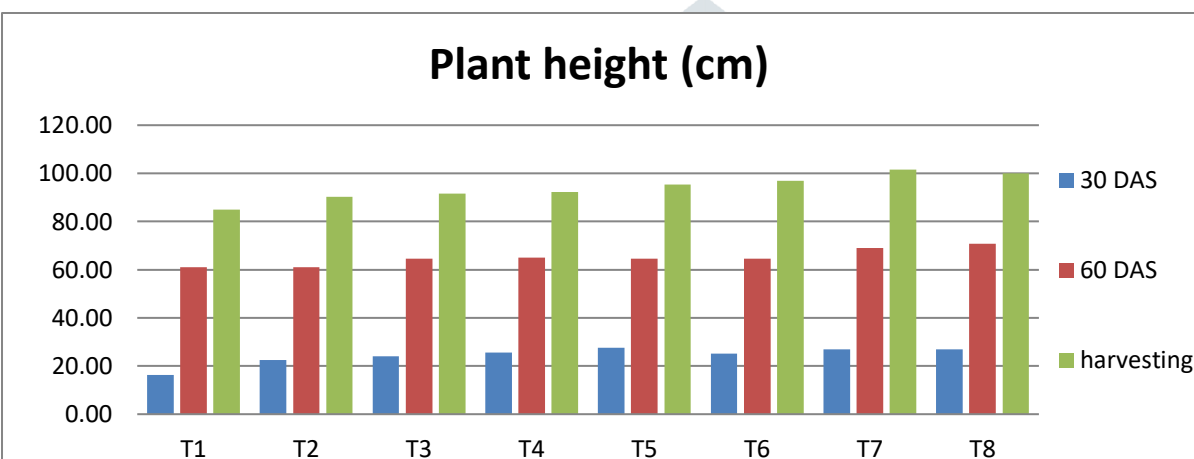
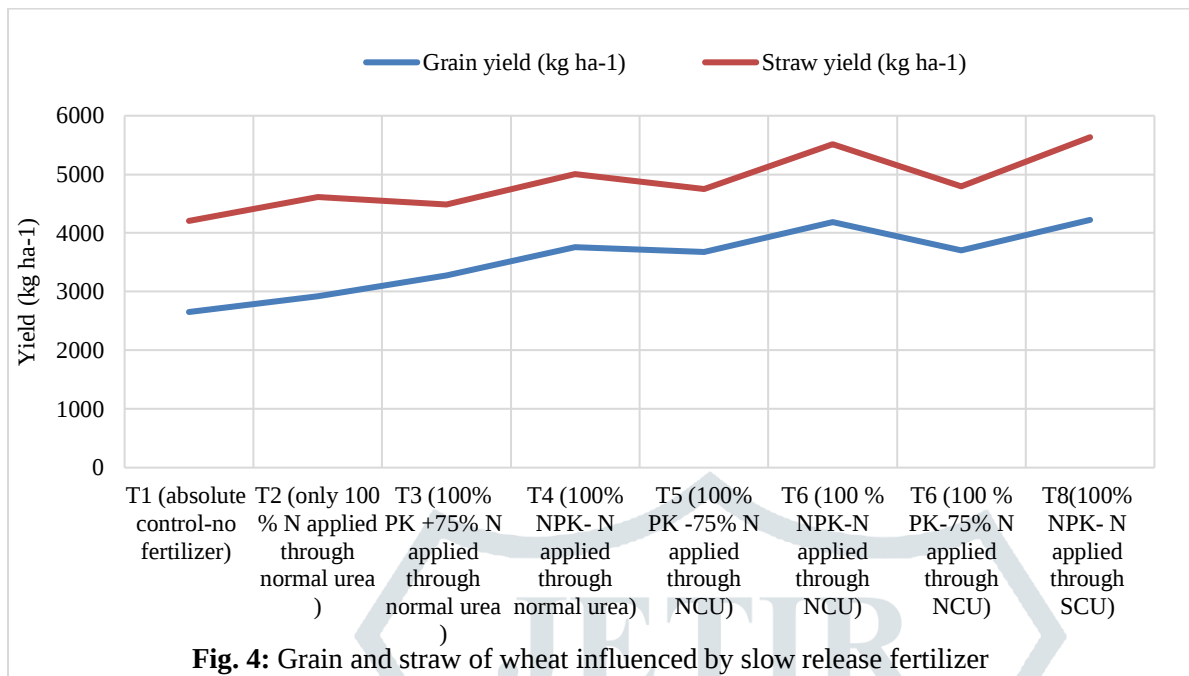


Fig .3. Plant height influenced by slow release fertilizer of wheat crop

Grain yield and straw yield of wheat crop-

The data of grain and straw yield of wheat revealed that the respond to application of nitrogen to wheat, invariable to source, had significantly enhanced grain and straw yield of wheat. The highest grain yield was obtained in T8 (100% NPK- N applied through SCU) followed by treatment T6 (100 % NPK- applied through NCU) as compared to unfertilized (control) and normal urea applied treatments. Further the application of normal urea also significantly increased grain yield over no fertilizer treatment. But there was no significant difference observed among the coated urea fertilizer (similar N dose) treatments with respect to grain yield and straw yield. The percent increase in grain yield due to application of SCU (100% N) NCU (100% N) and urea (100% N), along with 100% P K was 55%, 58.8% and 42.5%, respectively. Even in 75% N through SCU and NCU along with full doses of P and K increased the wheat grain yield significantly over control treatment. These findings could be ascribed to the beneficial effect of urea coating which controlled nutrient release and enhanced use efficiency of nitrogen by the wheat plant. (Eyvazi et al. 2010). Kramany (2001) reported that the slow-release N fertilizer produced higher biological yield of wheat. Similar result was obtained by Amal et al., (2007) with respect to biological yield of grain sorghum. Jadon et al. (2018) reported that maize grain yield was significantly lowered in unfertilized and normal urea applied treatments

as compared to resin coated and neem coated urea fertilizer applied treatment. Similarly, Shoji et al. 2001 in maize and Fan et al. 2004 also reported that coated urea performs better than regular fertilizers in rice.



Nutrients use efficiency-

Nutrients use efficiency in terms of AE (agronomic efficiency) and UE (utilization efficiency) of N, P and K for wheat significantly influenced by various fertilizer sources. Among the treatments, nitrogen use efficiency in terms of AE and UE, observed significantly lower in T2 treatment (100% nitrogen applied alone) while the highest recorded in T8 (100% NPK- N applied through SCU). moreover, the application of SCU (100%NPK-N applied through SCU) showed higher agronomic efficiency (AE) and utilization efficiency (UE) of phosphorus and potassium by wheat which was statistically at par with NCU (100%NPK-N applied through NCU) and were significantly higher compared to normal urea. Sulphur coated urea increase the nitrogen use efficiency (Shivay et al. 2016). Nitrogen application through coated urea increased its use efficiency by reducing N losses and releasing nitrogen in slow manner (Ning et al. (2012)). (Khanna et al. 2000) had reported that in comparison to prilled urea, coated urea produced higher rice grain yield and improved N use efficiency. Shivay (2003) also reported similar finding in rice

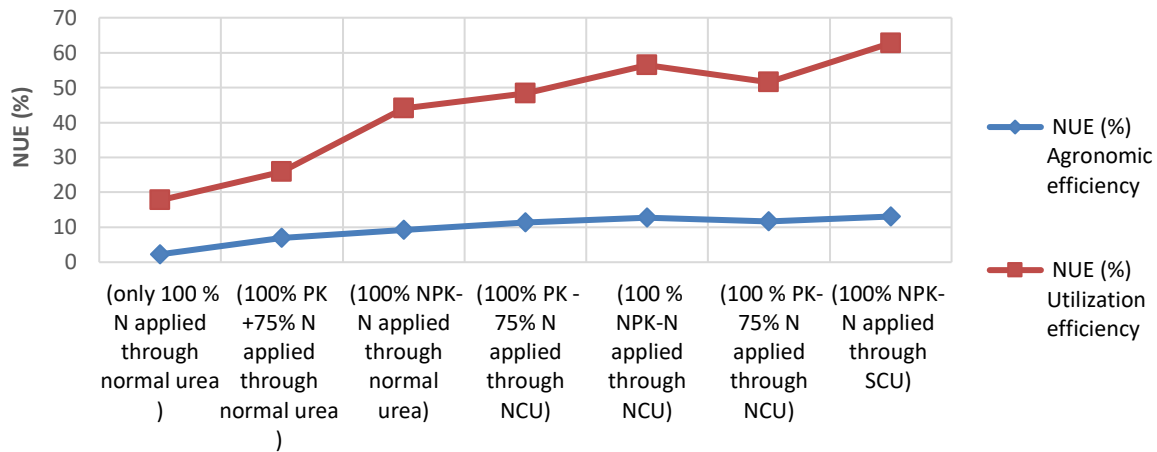


Fig. 5. : Nutrient use efficiency influenced by slow release fertilizer

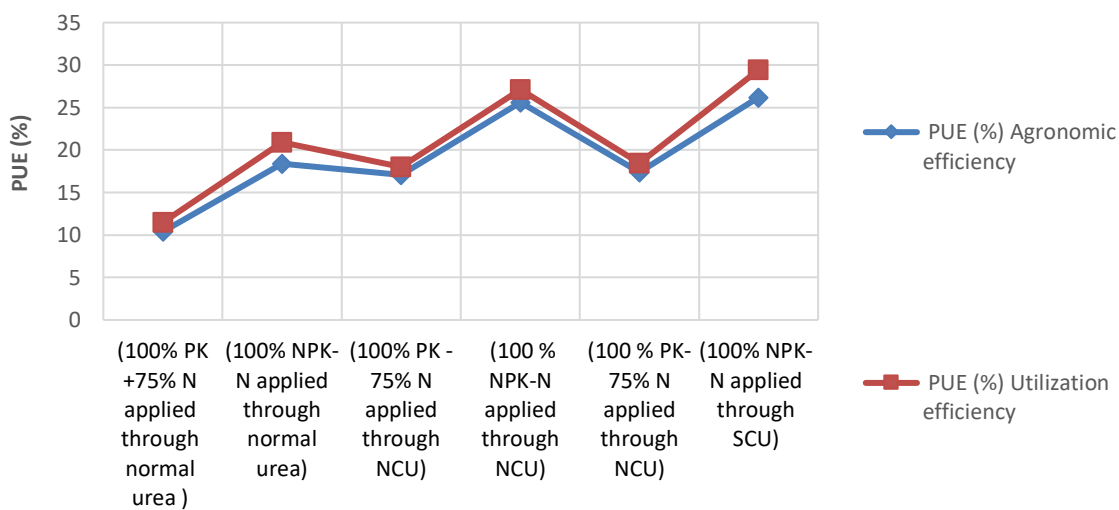


Fig. 6: Phosphorus use efficiency influenced by slow release fertilizer

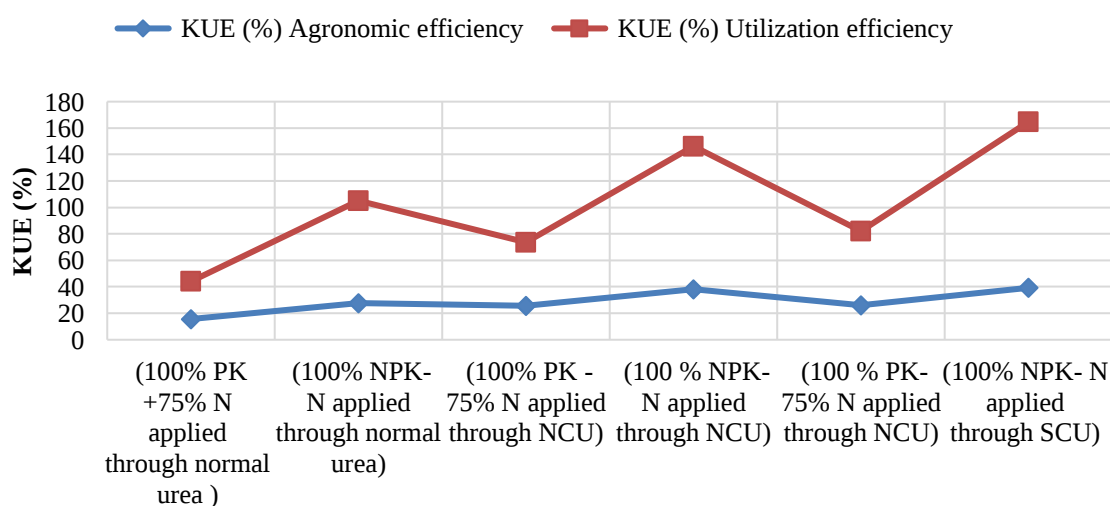


Fig .7: Potassium use efficiency influenced by slow release fertilizer

Conclusion

Slow release coated urea (sulphur coated urea and neem coated urea) fertilization resulted in improved wheat growth, yield and yield attributes. Further the coated urea also increased nutrient contents, uptake in grain and straw of wheat and its use efficiency in term of agronomic efficiency (AE) and utilization efficiency (UE). Moreover, the application of sulphur coated urea and neem coated also improved the soil health in term of soil organic carbon and soil available nutrients (NPK and S). It can be concluded that the use of sulphur coated urea low release coated urea was the best option of conventional urea for increasing wheat yields and improving soil health

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