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Effect of various rates of NPK on concentration, uptake and use efficiency of nutrients in linseed under saline sodic soil environment

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Abstract

Fertility status of saline-sodic soils is poor due to high concentration of soluble salts and exchangeable sodium percentage. Nitrogen concentration of these soils is low due to low organic matter content and high volatilization losses due to high pH. An experiment was carried on saline sodic soil to examine the effect of various levels of NPK on the concentration, uptake and use efficiency of NPK in linseed. The selected field was saline sodic in nature with sandy loam texture having pH value 8.57, SAR = 24.48 (mmol $L^{-1})^{1/2}$, ECe = 5.14 dS m^{-1} and deficient in OM. The experiment was comprised of five N levels i.e. (0, 105, 140, 175 and 210 kg of N ha^{-1}) with standard dose of P and K fertilizer. The experiment was repeated thrice under RCBD design. Intercultural operations were performed according to the experimental requirement. The crop was harvested at maturity & analyzed for N concentration and uptake in grains and straw, total N uptake by linseed and N use efficiency. The data regarding NPK concentration in grains and straw, NPK uptake by grains and straw, total NPK uptake by linseed and NPK use efficiency in linseed were determined. The all above parameters were enhanced by increasing fertilizer rate and maximum results were achieved in T_5 treatment where N was applied @ 210 kg ha^{-1} (150 % of recommended dose).

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Introduction

Linseed (*Linum usitatissimum* L.) also called alsi is cultivated for fiber and oil purpose. It is called flaxseed when cropped for fiber purpose. Linseed belongs to a family linaceae originated from Europe & Asia (Casa *et al*., 1999). The area cultivated with flax in whole world is 3.01 m ha yielding 852 kg ha $^{-1}$ annually on an average (FAO, 2007). The main world producers of flax are Russia, France, Belgium and Netherlands and that of linseed is Argentina, USA, Russia, India and Canada. The total world production of linseed and fiber flax has decreased. The average of national linseed grain yield in Pakistan is 692 kg/ ha (GOP, 2013). In Pakistan linseed yield is very low because of low soil fertility, insufficient use of chemical fertilizer and customary crop practices. Nutrient inequity acts to be the major reason for low linseed production in Pakistan. Determined crop production of linseed is attained by applying mineral nutrition in a right quantity & at right time (Cisse and Amar, 2000).

Due to salt stress the whole world is facing losses in agriculture productivity. The comparison of salt affected and normal conditions of soil demonstrated that yield decrease because of toxic levels of soluble salts in the rhizosphere was expressed as salt tolerance of a crop (Jouyban, 2012). In arid and semi-arid areas of the globe soil degradation due to salinity is a major environmental constraint having negative impact on agricultural productivity and sustainability. In the whole world, about 831 million hectare (mha), is affected by salts and it contributes 6.5% of the total (FAO, 2008). Saline and sodic soils collectively account for more than 50% of world's salt affected area. In the world out of total cultivated land about 23% is saline and 37% is sodic. At least 75 countries in the world are facing the problem of salt affected soils. Pakistan is included in these 75 countries. In Pakistan, 6.68 m ha is salt affected land (Khan, 1998). This salinity causes hyper osmotic and ionic stresses that lead to plant fatality. Plant growth can also be affected by salinity because of the occurrence of large quantity of soluble salts in solution of soil. Plant growth in the saline environment is affected due to reduced uptake, nutritional imbalance and toxic effect of ions (Nawaz *et al*., 2002).

Linseed showed a great response to N, P & K application. Nitrogen application along with proper amount of phosphorus increases the linseed yield. Its proper concentration promotes vital growth and color. This macro element nitrogen is applied to crops for their proper development (Fageria and Baligar, 2005). Nitrogen plays a key role increasing seed and fiber yield by enhancing cell number & size, protein production which results in cell division and fiber production. Application of nitrogen along irrigation water enhanced linseed production as it responds positively to nitrogen, but less than that of wheat, barley or oilseed rape. It was noted that the yield and quality of fiber increased by increasing levels of nitrogen. Increase in nitrogen levels, capsules/plants, seeds/capsule and consequently final yield of flaxseed was improved (Husain and Zedan, 2008). Nitrogen is a constituent of not only proteins but play a constitutional role in chlorophyll which is involved in photosynthesis. For flax production nitrogen is very essential element particularly under irrigation. Excess nitrogen application results in reduction of seed yield by promoting vegetative growth (Franzen, 2004). All characteristics of plants i.e. height, total biomass, protein contents and uptake enhanced with rising nitrogen levels.

Kariuki *et al.* (2014) performed a research to see the performance of 5 varieties (S19/21, Summit, Raja, Jawhar and S19/12) of linseed with different rates of nitrogen in two different seasons. The results illustrated that No. of leaves/plant, height of plant and yield was not appreciably affected with different rates of N fertilizer application. Raja performed better than other varieties in both seasons.

Singh *et al.* (2013) performed an experiment in the field on linseed. Increasing rates of fertilizer (NPK) application to the highest level resulted in superior growth and enhanced yield parameters of linseed. Application of NPK significantly improve growth and yield attributing characters and also enhanced dry

matter accumulation, capsule/plant, seed/capsule and 1000 seed weight. The incremental increase in nitrogen, phosphorus and potassium significantly delayed maturity of the crop. It might be due to prolonged vegetative phase of plants under high supply of nitrogen. Ali *et al*., (2011) observed the production potential of linola and linseed under various levels of nitrogen and concluded that linola performed significantly as compare to linseed. He observed that linseed cultivars chandni produced considerably higher number of tillers with the increasing rates of nitrogen. This experiment was planned to determine nutrient concentration, nutrient uptake and use efficiency of nutrients by linseed in saline sodic soil.

Material and methods

Experiment was conducted on sandy loam saline sodic soil. For site selection a preliminarily survey was conducted by taking six composite samples from different fields of SSRI research farm. After analysis one field was selected for conducting the research trail entitled, standardization of N, P, K dose for linseed crop in saline sodic soil. The field was prepared, leveled and linseed crop was sown at field capacity moisture level by adopting row to row distance 30 cm. The tested variety was chandni. Seed rate was 3 kg per acre. The experimental design was RCBD with three replications. Recommended dose of NPK was 150-150-75 kg ha^{-1}. Urea, single super phosphate (SSP) and sulfate of potash (SOP) were used as NPK sources. At maturity data regarding agronomic parameters was recorded. The plant samples were oven dried at 65° C till constant weight. The grain and straw samples were ground and digested for total nitrogen, phosphorus and potassium and Total NPK was resulted by the modified Kjeldhal method (Jackson, 1962). The soil samples before sowing of linseed crop were taken from saline sodic field and characterized for physical and chemical determinations. The soil samples were analyzed for the physical and chemical characteristics soil texture, pH of saturated soil paste, Electrical conductivity, and Sodium and Organic carbon. Collected Data was subjected to analysis of variance (ANOVA) by using randomized block design of layout (Steel and Torrie, 1980) and means were compared by using Duncan's Multiple Range Test (Duncan, 1955).

The selected field was saline sodic in nature with pH_s value 8.57, EC_e = 5.14 dS m^{-1}, SAR = 24.48 (mol $L^{-1})^{1/2}$, deficient in organic matter.

Results and discussion

NPK concentration in Linseed grains

The NPK concentration in grains of linseed was affected significantly with different increasing rates of fertilizer application in saline sodic soil. Their concentration in grains of linseed varied from 1.80% to 3.20%, 0.140% to 0.440% and 0.26 % to 0.68%.

Table 1. Basic soil analysis of the selected field.

Parameters	Values	Units
pH_s	8.57	
EC_e	5.14	dS m^{-1}
TSS	54.5	me L^{-1}
$Ca^{2+} + Mg^{2+}$	7.4	me L^{-1}
Na^{+}	47.1	me L^{-1}
SAR	24.48	(mmol $L^{-1})^{1/2}$

Maximum NPK concentration in grains of linseed (3.20%, 0.440% and 0.68%) was noted where fertilizer was applied @ of 210-210-112.5 kg ha^{-1} (Figure 1) and it was 77.77%, 214.28% and 161.53% superior than control, and these treatment differed non-significantly with T_4 where N was applied @ of 175-175-93.75 kg ha^{-1} and significantly with T_3, T_2 and T_1. T_4 differed non-significantly with T_3 while

significantly with T_2 and T_1. And T_3 also differed non-significantly with T_2 and significantly with T_1. T_2 and T_1 also differed non-significantly. Minimum NPK concentration in grains of linseed (1.80%, 0.140%) was recorded in treatment where no fertilizer application was done. The results are in line to the findings of Ali *et al.*, (2011) that increasing fertilizer rates increased NPK concentration in the grain and straw of linseed.

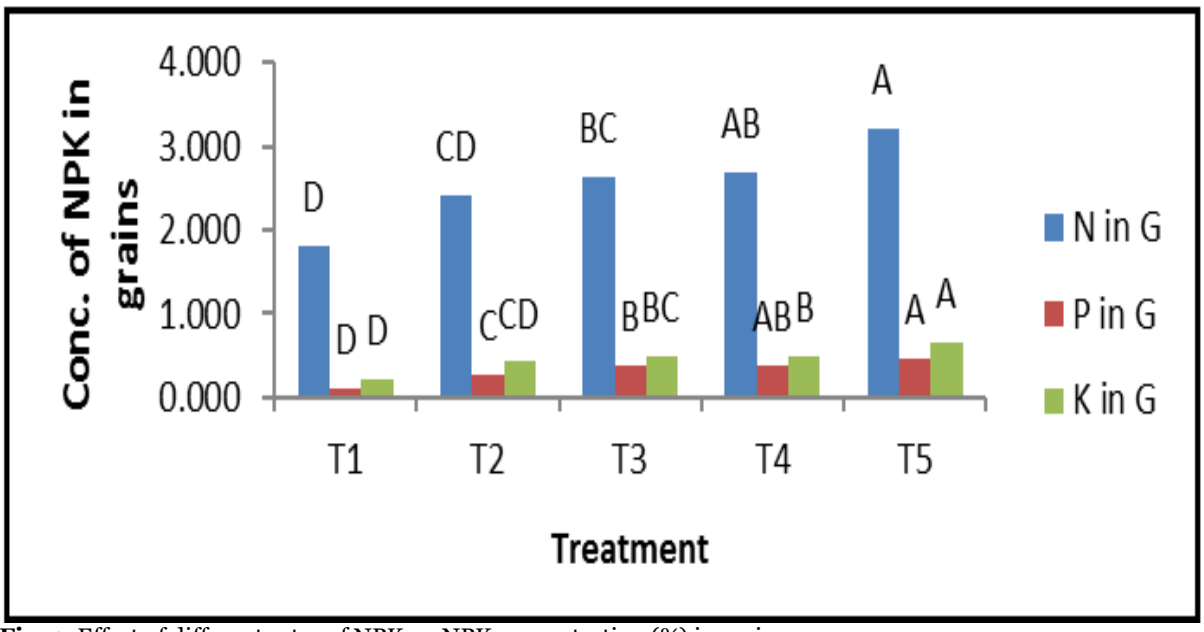


Fig. 1. Effect of different rates of NPK on NPK concentration (%) in grains.

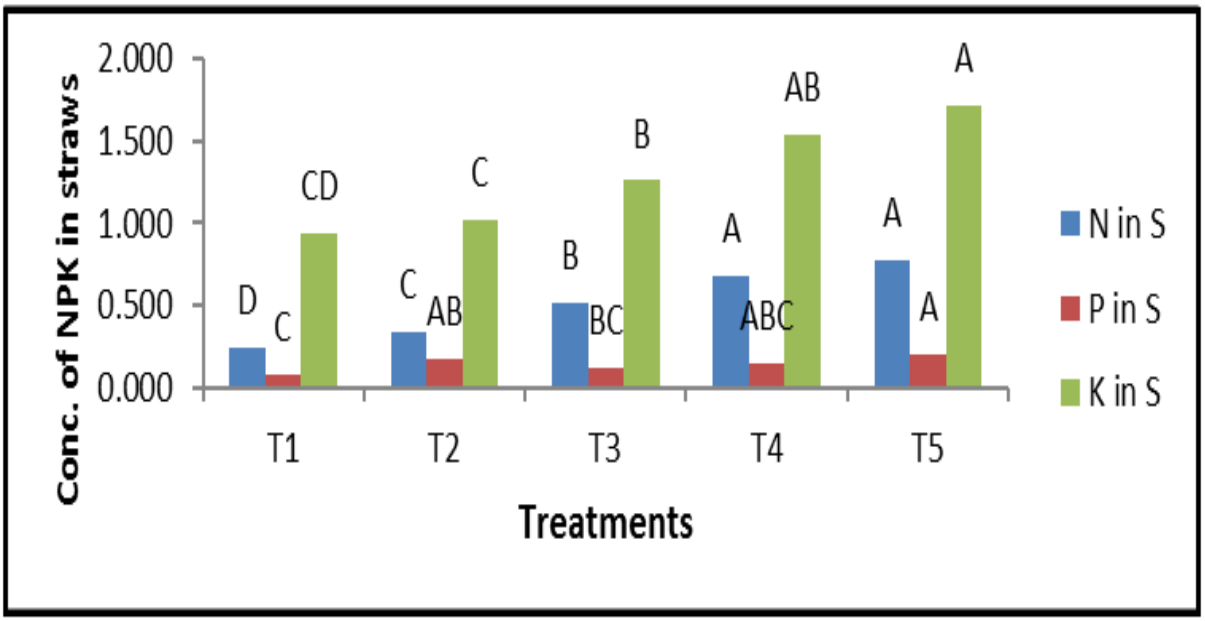


Fig. 2. Effect of Different rates of NPK on NPK concentration (%) in straw.

NPK concentration in Linseed straws

The nitrogen, phosphorus and potassium concentration in straw of linseed varied from 0.22% to 0.76%, 0.080% to 0.176% and 0.84% to 1.52%. Highest N, P, K concentration in straw of linseed (0.76%, 0.176% and 1.52%) was found where fertilizer was applied @ of 210-210-112.5 kg ha^{-1} (Figure 2) and it was 245.45%, 120% and 80.95% greater than control, and this treatment differed non-significantly with T_4 where fertilizer was @ of 175175-93.75 kg ha^{-1}

and significantly with T_3, T_2 and T_1. T_3 differed non-significantly with T_2 while significantly with T_1. And T_2 also differed non-significantly with T_1. Minimum nitrogen concentration in straw of linseed (0.22%, 0.080% and 0.84%) was observed in treatment where no fertilizer was applied. These results are similar to the findings of Sattar *et al.*, (2011) that increasing rates of nitrogen, phosphorus and potassium application increased their concentration in the grain and straw of linseed.

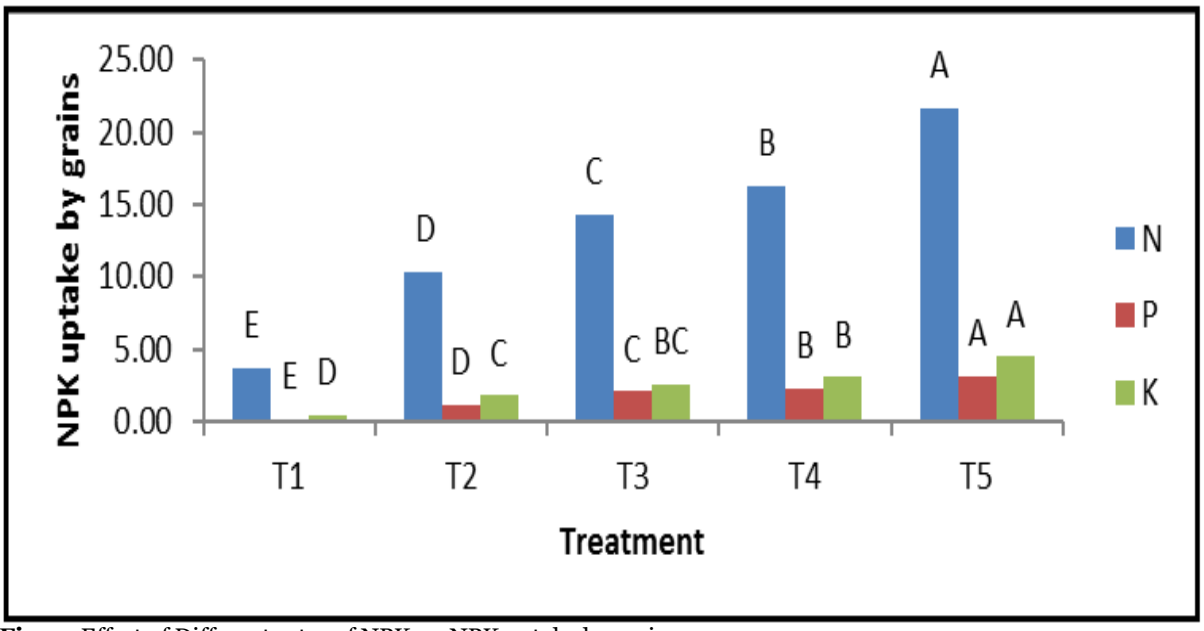
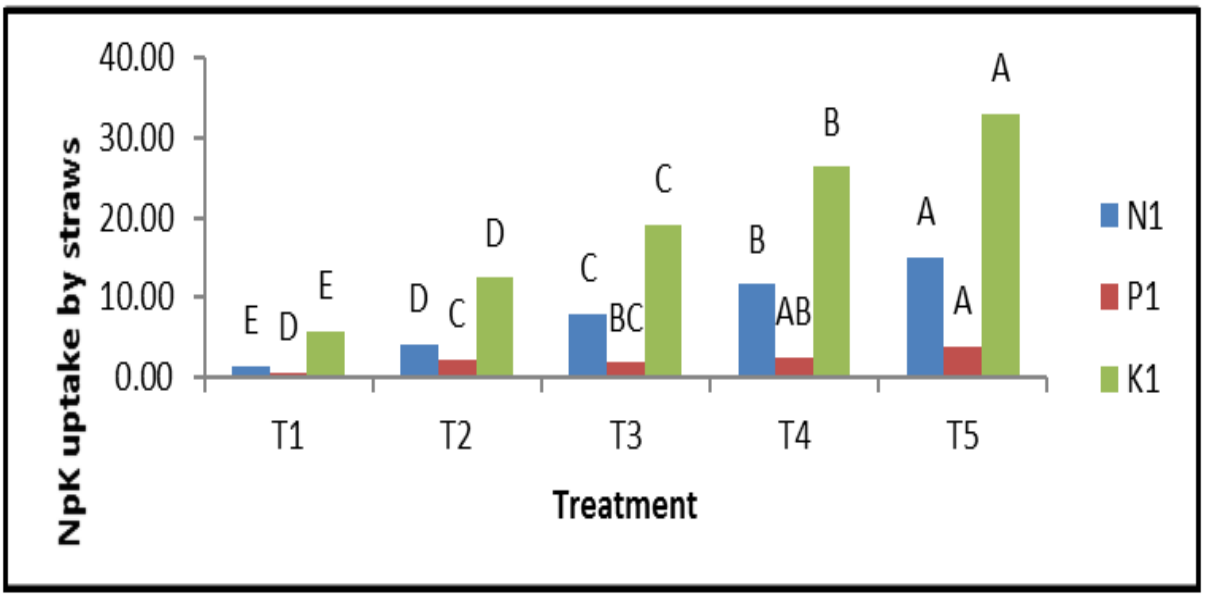


Fig. 3. Effect of Different rates of NPK on NPK uptake by grains.



Fig, 4. Effect of Different rates of NPK on NPK uptake by straw.

NPK uptake by linseed grains

The NPK uptake by grains of linseed was significantly affected by various rates of fertilizer applied in saline sodic soil and varied from 3.67 kg ha^{-1} to 22.62 kg ha^{-1}, 0.28 kg ha^{-1} to 3.10 kg ha^{-1} and 0.53 kg ha^{-1} to 4.81 kg ha^{-1}. Remarkable N, P, K uptake by grains of linseed was recorded where fertilizer was applied @ of 210-210-112.5kg ha^{-1} (Figure 3) and it was 516.34%, 1007.14% and 807.54% greater than control, and this treatment differed significantly with T_4, T_3, T_2 and T_1. Singh *et al.* (2013) concluded the similar results from his research.

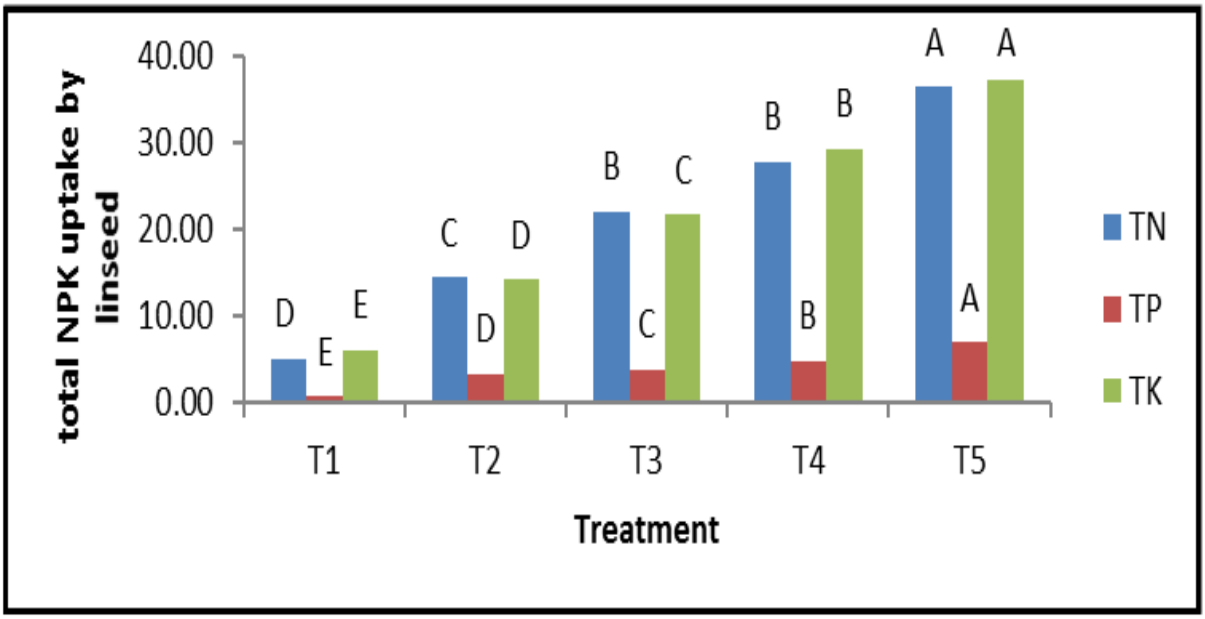


Fig. 5. Effect of Different rates of NPK on total NPK uptake by linseed.

NPK uptake by linseed straws

The NPK uptake by straw of linseed varied from 1.36 kg ha^{-1} to 14.82 kg ha^{-1}, 0.48 kg ha^{-1} to 3.43 kg ha^{-1} and 5.11 kg ha^{-1} to 29.60 kg ha^{-1}. Various rates of NPK significantly affect nitrogen uptake by straws of linseed. Maximum nitrogen uptake by straw of linseed (14.82 kg ha^{-1}, 3.43 kg ha^{-1} and 29.60 kg ha^{-1}) was found in the treatment where NPK was applied @ 210-210-112.5 kg ha^{-1} (Figure 4) and it was 989.70%, 614.58% and 479.25% superior to control, and this treatment differed significantly with T_4, T_3, T_2 and T_1. Lal *et al.*, (2011) also concluded the similar results that the increasing rates of NPK application increased their uptake.

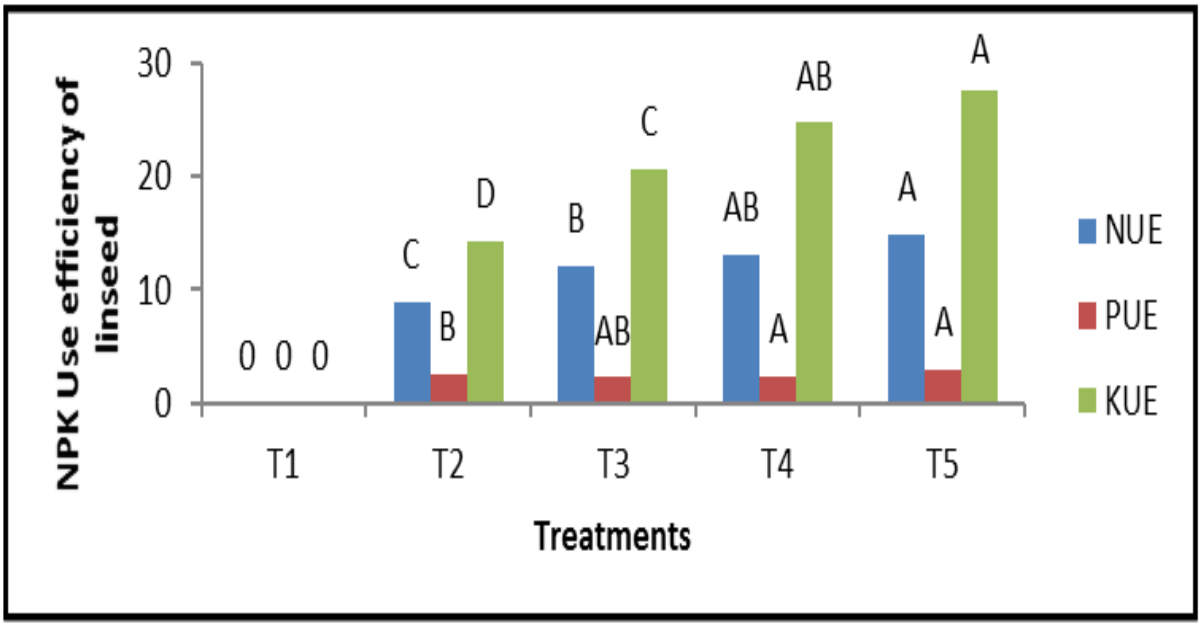


Fig. 6. Effect of Different rates of NPK on NPK use efficiency of linseed.

Total NPK uptake by linseed

The total uptake of NPK by linseed was affected significantly with different rates of NPK application in saline sodic soil and varied from 1.36 kg ha^{-1} to 14.82 kg ha^{-1}, 0.76 kg ha^{-1} to 6.53 kg ha^{-1} and 5.65 kg ha^{-1} to 34.41 kg ha^{-1}.

Maximum nutrients uptake by linseed was gained in the treatment T_5 (210-210-112.5 kg ha^{-1}) (Figure 5) and it was 644.33%, 759.21% and 509.02% greater than control and this treatment differed significantly with T_4, T_3, T_2 and T_1.

These results are in line with Shaaban *et al.*, (2012) that the uptake of nutrients enhanced with increasing fertilizer application in loamy soils.

NPK use efficiency of linseed

The NPK use efficiency of linseed varied from 0% to 15.43%, 0% to 2.74% and 0% to 25.56%. Various levels of fertilizer significantly affect nitrogen use efficiency of linseed. Maximum NPK use efficiency of linseed (15.43%, 2.74% and 15.43%) was obtained in plots where fertilizer was applied @ of 210-210-112.5 kg ha^{-1} (Figure 6) and this treatment differed non-significantly with T_4 and T_3 and significantly with T_2 and T_1. Where, T_3 treatment also differed non-significantly with T_2 and significantly with T_1. Control treatment showed the minimum nitrogen use efficiency of linseed (%). These results are similar to the observations of Rahimi *et al.* (2011).

Conclusion

It was concluded from the present results that the increasing rates of nitrogen significantly affect the concentration, uptake and NPK use efficiency of linseed. All these parameters increased with increasing nitrogen rates.

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