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Effect of Nitrogen and Phosphorus on the Growth and Yield of Alfalfa (*Medicago sativa* L.) under Agro-Climatic Conditions of Tando Adam

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Abstract
Indecent use of nitrogen and phosphorus along with other production factors is the main cause of low yield of Alfalfa (Lucerne) in Pakistan. To inquire the fact, a field experiment was conducted to find out the impact of nitrogen and phosphorus on the growth and production parameters of Alfalfa. Seven different levels of Nitrogen and Phosphorus i.e. (T_1=0:0, T_2=0:50, T_3=25:50, T_4=50:50, T_5=75:50, T_6=100:50, and T_7=125:50 kg / acre) in the form of urea and DAP were used in a randomized complete block design (RCBD) replicated three times on Alfalfa. Phosphorous fertilizer dose applied at sowing and nitrogen was applied in split doses by broadcasting. After compiling the results it was known that overall treatment T_5 positively affected all growth and yield parameters of alfalfa. Overall maximum plant height (44.78 cm), number of leaves / stem (13.36), leaf area / plant (55.05 cm^2), plant density (992.57), mean dry fodder yield (2.16 tons/acre/cut) and crude protein (17.214 %) was obtained in treatment T_5. Nearly same results i.e. Crude protein (17.139%) were achieved by treatment T_6 but the dry fodder yield (1.92 tons/acre/cut) was recorded less. Control plots i.e. T_1 where no fertilizers were applied remained inferior for all characteristics. Application of too low or high NP levels reduced the yield and yield parameters of Alfalfa.
Keywords: Alfalfa, Nitrogen Fertilizer, Phosphorous Fertilizer, Irrigation, Agriculture, Pakistan.

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INTRODUCTION

The alfalfa (*Medicago sativa* L.) is also called as Lucerne and it is a perennial flowering plant in the pea family (Taylor, 1998). It was originated from South-West Asia. It is deep rooted and can be grown under rain-fed or less irrigated conditions as an annual or perennial crop (Martin *et al.,* 2005). Alfalfa is a very palatable and nutritive forage legume containing about 15% - 20% crude protein. Alfalfa is also rich in vitamins and has low fibre content; this is why it is termed as queen of forages (Shahriari *et al.,* 2007). Alfalfa requires deep loamy soils rich in phosphorus and potash. It also require well pulverized and tilt soil. Alfalfa adds nitrogen to the soil and improves the soil fertility. Fine seedbed ensures proper germination. The land should to be leveled and made into the compartments for uniform irrigation and proper drainage. To get good germination pre-sowing irrigation is very much essential. Fertilizer application of NPK should to be given according to the soil test prescription. It is mainly grown for green fodder, hay and silage (López *et al.,* 2010).

Sowing is taken up either by broadcasting or line (drill) sowing. The seed rate is 20 – 25 kg/ha for broadcasting and 12 - 15 kg/ha for line sowing respectively. In line sowing the rows are kept 30 cm a part (Qamar *et al.,* 2000). Alfalfa being sensitive to climate requires cool and dry weather during its seedling growth. For successful establishment of a crop frequent irrigations are given at 10 days interval (Mirza *et al.,* 2002). Weeding and hoeing operations are very much essential during its early stages of growth. It could be done manually or by using machines to pull out the weeds. Alfalfa normally lives four to five years and more, depending on temperature and climatic conditions. Harvesting of the green fodder starts from 55 to 70 days after sowing. In arid climatic conditions of alfalfa can be harvest eight to ten times a year as the plant starts to regenerate from the stubbles (Borhan *et al.,* 2000). A mild and hot dry condition favors the vegetative

growth of the plant. Alfalfa hay is used mostly for the horses while in dehydrated form it is melted to get meals for the poultry.

It has been observed from past studies that alfalfa responded well to nitrogen fertilizer after a basic pre-plant phosphorous application. Production of alfalfa was remarkable when nitrogen fertilization was applied in a separate split dose (Brima, 2011). However, the excessive use of fertilizers with irrigation water in the field of alfalfa can reduce the quality and production parameters (Arshad, 2012). The present investigation was conducted at Siddique Farms Tando Adam, Sindh – Pakistan to find out the yield and growth rate of alfalfa with the application of different rates of NP fertilizers.

MATERIALS AND METHODS

The present study was conducted in Siddique Farms Tando Adam, Sindh – Pakistan in September 2015. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Thus, the total numbers of plots were twenty-one and the size of each plot was (12m x12m). With the objective to ensure uniform distribution of irrigation water, initially weeds and extra grass were cleared by using two split crosswise cultivator operations supplemented with disk plow respectively. The land was then rough leveled by tractor with front and rear blade. In order to break the big mud stones (particles) of soil in to small fine particles the wooden deck and rotavator was used to ensure effective germination. After leveling pre-irrigation of 1 acre-inch of irrigation water was supplied in order to observe re-growth of grass and weeds. Then after 4-5 days the grown weeds and grass were cleared by using cultivator and tooth harrow operation accordingly. Finally, with the help of border maker the prepared land was divided into small sub-plots to carry out the research study.

Treated seeds of alfalfa i.e. 8 kg/acre were planted on September 15, 2015, in the prepared land and Phosphorous fertilizer dose applied at sowing accordingly. The fertilizers treatments comprised of seven dozes i.e. (T_1=0:0, T_2=0:50, T_3=25:50, T_4=50:50, T_5=75:50, T_6=100:50, and T_7=125:50 kg / acre) respectively. Nitrogen was applied in split doses by broadcasting. Altogether two cuts at 50% flowering stage were obtained during the study period and the first cut was harvest after 75 days after sowing respectively. 20 plants were selected at random in each plot at 50% flowering stage for cutting the Alfalfa crop for fodder purpose. The economic and qualitative parameters studied during the research study was plant height, number of leaves per stem, leaf area per plant, plant density, dry fodder yield, crude protein, crude fibre, and ash contents respectively. For quality tests the dried samples of alfalfa hay from all the plots on composite basis were chopped separately into small pieces and send to Qualitest Laboratory, North Nazimabad, Karachi - Pakistan; where proximate composition was conducted. Finally, data analysis and statistical analysis were done through ANOVA procedure.

RESULTS AND DISCUSSION

The present research was carried out to check the yield and growth rate of Alfalfa (Lucerne) with the application of different rates of NP fertilizers. The outcome of the results revealed that Alfalfa plant height, number of leaves per stem, leaf area per plant, plant density, dry fodder yield, crude protein, crude fibre, and ash contents differed very significantly between application of different rates of NP fertilizers as shown in (Table 1), and (Table 2) respectively. The critical gathered observations and data for the above discussed parameters during the research study are appended below:

Economic Characters Studied for Alfalfa

Plant Height

Statistically significant results were observed for plant height among the different fertilizers levels as shown in (Table 01). Plants fertilized with treatment T_5 were significantly taller than all the other treatments. The overall highest plant height of (44.78 cm) was recorded for T_5, followed by T_6 where plant height of (42.34 cm) was noted. However, the minimum overall plant height (22.95 cm) was recorded for T_1 respectively. From the obtained results it is clear that due to the deficiency of major nutrients in Alfalfa the growth of the plants becomes slow due to which plants did not attain good height. Similar results were obtained for plant height for alfalfa by (Alkhatem *et al.,* 2014).

Number of Leaves / stem

Fertilizers levels had a significant effect on number of leaves per stem as mentioned in (Table 01). Number of leaves / stem with treatment T_5 (13.36) were significantly overall more than the other treatments. Once again T_1 showed overall less number of leaves / stem (6.83). Similar results were obtained for number of leaves / stem for alfalfa by (Ali, 2000).

Leaf Area / Plant (cm^2)

According to the obtained results it has been observed that overall leaf area with treatment T_5 was significantly more as compared to all other doses applied. Maximum overall leaf area of (55.05 cm^2) was recorded for T_5 dose followed by T_6 (50.09 cm^2) as shown in (Table 01). However, the minimum overall leaf area (24.08 cm^2) was recorded for T_1 respectively. Similar results were obtained for leaf area for alfalfa was reported by (Costa *et al.,* 1999).

Plant Density

Statistically significant results were observed for plant density (Table 1). Once again the fertilizer treatment T_5 possessed significantly more plant density as compared to control and all the other treatments.

Table 1. Effect of different levels of NP application on quantitative parameters of Alfalfa

Fertilizer Treatment (kg/acre)	Plant Height (cm)		No. of Leaves / stem		Leaf area / Plant (cm^2)		Plant Density		Dry Fodder Yield (Tons/acre/cut)		
N:P	1st Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut	Avg.
T_1	26.82ef	22.95e	7.14e	6.83e	25.26e	24.08e	384.63f	329.68f	0.94d	0.81d	0.87
T_2	26.84e	31.31de	8.89cd	10.37cd	27.83de	32.47cd	431.41de	503.37de	1.03c	1.20cd	1.12
T_3	28.12cd	32.84d	9.40c	10.97c	28.11d	32.80cd	467.65d	545.60d	1.19ab	1.39c	2.59
T_4	31.49bc	36.65c	10.62b	12.40b	33.13cd	38.66c	537.41cd	626.98c	1.48a	1.73b	1.61
T_5	38.35a	44.78a	11.45a	13.36a	47.18a	55.05a	850.77a	992.57a	1.99a	2.33a	2.16
T_6	36.27ab	42.34ab	11.14ab	12.99a	42.93b	50.09ab	650.63b	759.07b	1.77a	2.07a	1.92
T_7	33.07b	39.09b	10.44b	12.19b	35.88c	41.86b	558.10c	651.12bc	1.27ab	1.49bc	1.38

Means followed by different letter shows significant result at 5% level of significance.

The maximum overall plant density (992.57) were noted in the T_5 fertilizer dose and the next best dose was T_6 (759.07) respectively. Once again T_1 showed overall less plant density (329.68). These results are in agreement with (Halim, 1987) for alfalfa.

Dry Fodder Yield

It had been observed that due to the application of different doses of NP fertilizers there was a very significant increase in dry fodder yield. On average basis the maximum overall yield of (2.16 tons/acre/cut); significantly higher among all the other treatments, was recorded for T_5 treatment. On the basis of average dry fodder yield of altogether two cuts, it is evident that T_5 produced 60% approximately more dry fodder yield as compared to the control treatment (Table 1). Similar results were obtained for dry fodder yield for Rhodes grass by (Arshad, 2015).

The above economic characters i.e. plant height, number of leaves per stem, leaf area per plant, plant density, and dry fodder yield, showed that high fodder yield with T_5 treatment can be attributed to these plant characters. Therefore, selection for one character will result in the improvement of all the desirable agronomic characters of alfalfa (Lodge, 1986).

Qualitative Parameters Studied for Alfalfa (Lucerne)

To determine the quality and nutritive value of different qualitative parameters of alfalfa the dried samples of all the plots were chopped separately into small pieces and send to Qualitest Laboratory, North Nazimabad, Karachi, Pakistan. The qualitative parameters studied were crude protein, crude fibre, and ash contents respectively. The data revealed that the mean highest crude protein contents of (17.214%) were recorded with T_5 followed by T_6 i.e. (17.139%) respectively. The control treatment T_1 had (9.834%) crude protein (Table 2). These results are in accordance with those of (Ahmed *et al.,* 2013).

Table 2. Effect of different levels of NP application on qualitative parameters of Alfalfa (Average of 2 cuts)

Treatments (kg/acre)	Crude Protein	Crude Fibre	Ash
N:P	(%)	(%)	(%)
T_1	9.834e	28.011a	8.104a
T_2	10.324d	29.403a	8.121a
T_3	14.74cd	29.078a	8.143a
T_4	15.523c	29.925a	8.291a
T_5	17.214a	31.150a	8.813a
T_6	17.139a	29.034a	8.641a
T_7	15.840bc	28.931a	8.395a

Means followed by different letter shows significant result at 5% level of significance.

CONCLUSION

From the results obtained it could be concluded that maximum plant height (44.78 cm), number of leaves / stem (13.36), leaf area / plant (55.05 cm^2), and plant density (992.57) were produced in treatment T_5. These factors contributed towards highest mean dry fodder yield (2.16 tons/acre/cut) and crude protein (17.214 %) in this treatment T_5. Nearly same results i.e. Crude protein (17.139%) were achieved by treatment T_6 but the dry fodder yield (1.92 tons/acre/cut) was recorded less. From results it has also been observed that the overall agronomic parameters were at higher stage in 2nd cut as compared to the 1st cut except for T_1 treatment as control plots showed un-satisfactory results regarding all the parameters. Application of too low or high NP levels reduced the yield and yield parameters of alfalfa. Hence, the fertilizer dose T_5 is recommended for getting the maximum tonnage of dry matter with good quality of Crude protein contents in Alfalfa under arid conditions of Tando Adam, Sindh – Pakistan. However, further

investigation is necessary to establish the present findings in other regions of Pakistan with Alfalfa.

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CONFLICT OF INTEREST

There is no conflict of interest.

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