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## SUMMARY

Two experiments were designed and carried out at Ismailia Agricultural Research Station, Agricultural Research Center, Ismailia Governorate, in three successive years through 2003-2005 for the field experiment and two successive years (2003-2004) for the pot experiment.

### **1- The Field Experiment:**

The main objective of this experiment was to investigate the effect of various levels of N P K combinations on the productivity, quality and nutrients uptake of some exotic and local alfalfa cultivars, under sandy soil in Ismailia Governorate through three successive years of 2003-2005.

The experiment was laid out in a split-plot design in 4 replications. The NPK treatments were randomly assigned in the main plots. The four applied fertilization treatments under study were formulated as follows: four nitrogen fertilization levels of 0, 10, 20 and 30 kg N/fed. applied as ammonium nitrate (33.5% N). In addition, four phosphorus levels of 0, 10, 20 and 30 kg P/fed were applied as super phosphate (6.5 % P) during soil preparation. The Potassium (K) was applied at four levels of 0, 10, 20 and 40 kg K/fed as potassium sulfate (43% K). The three nutrients (N, P, K)

were combined together and applied in the following combination: control 0N – 0P – 0K, low 10N – 10P- 10K, Medium 20N- 20P-20K and high 30N- 30P- 40K. Amounts of NPK were applied in four application. Each one of the above mentioned combinations applied during establishment and a weak later right after Spring, Summer, Autumn and Winter seasons each year followed by irrigation.

Moreover, micronutrients combinations (Fe, Zn and Mn were applied at a rate of 5 kg/fed. as Fe, Zn and Mn in EDTA formulation having 12% of each of the concerned element. Copper was applied as  $\text{CuSO}_4$  at a rate of 5 kg/fed as well as two kg/fed of each of the ammonium molybdate and boric acid were added as a sources for Mo and B. These amounts of micro nutrients were applied in four equal doses in each of the four seasons of each year.

The five alfalfa cultivars include three exotic cultivars (Hallma, Melesia from France and Siriver from Austrelia) and tow local cultivaers (Sewa and Ismailia-1) from Agricultural Research Center, Forage Dept., Egypt. These cultivars were located in the sub plot of the experimental units

**The most important results could be summarized as follows:**

**Fresh and dry forage yield:**

Over the applied fertilization treatments each of the three exotic alfalfa cultivars were significantly lower in yearly and total yield than any of the grown local cultivars (Ismalia-1 and Sewa).

Concerning the local cultivars, Ismailia-1 was of the highest yearly and total forage yield followed by Sewa. The high, medium and low fertilizer treatments caused substantial increase in dry alfalfa forage yield compared to the control by 135, 89, and 39 % in the first year, being 89, 51 and 29 % in the second year and 85, 46 and 25 % in the third year. Seasonal total forage yield (fresh and dry) under each fertilization treatment was higher in spring season followed by summer then autumn where the lowest forage yield was produced in winter.

-There was greater response to the highest NPK fertilization level in summer season; then spring; followed by autumn. Whereas, the lowest dry forage yield (fresh and dry) was produced during winter seasons as compared with their relevant control received the lowest NPK fertilization levels.

- Dry leaf/stem ratio during the stand duration indicated the superiority of summer seasons which gave the highest values of dry leaf/stem ratio, while the lowest values resulted during spring seasons of the whole stand duration of 3 years.
- The local cultivars Ismailia-1 proved to produce the highest dry leaf/stem ratio with highly significant differences as compared with the other tested four alfalfa cultivars. The second highly ranked cultivar in dry leaf/stem ratio was the local Sewa alfalfa.
- Height of alfalfa plants substantially increased as the fertilization levels increased from the control up to the highest fertilization treatments with various magnitudes.
- The tallest height of alfalfa plants was obtained by either one of the grown local cultivars (Ismailia-1 and Sewa) using the highest fertilization treatments (T4) with relatively more effect for Ismailia-1 than Sewa. Whereas, the shortest alfalfa plants were noticed for any of the grown exotic cultivars (Siriver, Melesia and Hallma) without or with the lowest fertilization treatments.
- The tallest seasonal plant heights during the stand duration indicated the superiority of summer season; being slightly

decreased during spring seasons; followed by autumn; then winter seasons where the shortest plants were produced.

- The local alfalfa cultivars, Ismailia-1 produced the tallest plants during winter, spring, summer and autumn seasons, whereas, the exotic cultivar Hallma produced the shortest plants in corresponding seasons.

- The highest seasonal number of shoots/m<sup>2</sup> during the stand duration indicated the superiority of winter season; being slightly decreased during spring season; followed by autumn; then summer season.

- Winter season was superior in number of shoots/m<sup>2</sup> among the other seasons. Using high, medium and low fertilization treatments caused an increase in number of shoots/m<sup>2</sup> as compared with their relevant control treatments by 79, 48 and 19%, respectively. Such differences in increasing number of shoots/m<sup>2</sup> were magnified as the fertilization level increased from low (T2 ) to medium (T3 ) and up to the highest (T4 ) level.

### **Chemical composition:**

- Highest crude protein content of alfalfa was obtained in winter season. Meanwhile summer season produced alfalfa

plants of the lowest CP content which very slightly increased in autumn.

- During winter seasons, the exotic cultivars (Hallma, Melesia, and Siriver) contained almost similar CP content which are relatively higher than those of the two local ones Sewa and Ismailia-1 with slight higher CP for the later than the earlier cultivar. Meanwhile, the highest CP content among the grown alfalfa cultivars was Siriver in spring, Ismailia-1 in summer and Melesia in Autumn. Whereas, the lowest CP content was for Sewa in winter and spring, Melesia in summer, and Ismailia-1 in Autumn season.

-There was a slight increase in CF content in summer than spring and in autumn than winter. So, the lowest CF content of alfalfa forage was noticed during winter. CF content was decreased with increasing fertilization level.

-There was a slight increase of ash content in winter than spring and in autumn than summer. The highest ash content was for Hallama in winter, Melesia in spring and autumn and Ismailia-1 in summer season. An increase in ash content was noticed with increasing the level of fertilization.

-EE content of alfalfa plants substantially increased with increasing N, P, K combination level.



-The lowest Ether extract (EE) content among the grown alfalfa cultivars was Sewa and Siriver in winter, Sewa and Ismailia-1 in spring and Sewa during summer and autumn. Whereas, the highest EE content was for Melesia in winter, spring, summer and autumn season.

-Alfalfa forage was of the lowest NFE content in winter and spring as compared with summer and autumn. Also, there was a slight increase of NFE content in autumn than summer and in spring than winter. So, the lowest NFE content of alfalfa forage was noticed in winter.

-The applied fertilization treatments increased from low (T2) to medium (T3) and up to the highest level (T4) concomitant with substantially decrease in NFE content.

-The highest NFE content among the grown alfalfa cultivars was Melesia in winter, Ismailia-1 in spring and summer, Ismailia-1 and Melesia in autumn. Whereas, the lowest NFE content was for Hallma and Siriver in spring, Sewa in spring, Melesia in summer and autumn season.

- The lowest TDN content among the grown alfalfa cultivars was for Sewa in winter and spring, Melesia in summer and Sewa in autumn. Whereas, the highest TDN content was for Melesia in winter and summer, and Siriver in spring season.

- The highest seasonal (combined over the two first years) N uptake during the stand duration indicated the superiority of winter; decreased slightly during autumn seasonal; followed by spring and summer seasons.

-Over all the applied fertilization treatments, During winter seasons, N contents of the exotic cultivars ( Hallma, Melesia and Siriver) were significantly lower than those of the two local ones (Sewa and Ismailia-1). Meanwhile, the highest N content among the grown alfalfa cultivars was in Ismailia-1 in winter, spring, summer and autumn seasons. Whereas, the lowest N content was for Hallma in winter, spring, summer and autumn seasons.

- Seasonal N uptake under each fertilization treatment was higher in winter season followed by autumn then spring where the lowest N uptake was produced in summer season.

- The high combined fertilization treatment (T4) significantly enhanced alfalfa plants which produced the highest N uptake values of 95.62, 70.59, 43.18 and 78.39 in winter, spring, summer and autumn seasons compared with their control values of 31.037,24.40, 22.53 and 25.35 for the same corresponding seasons.

-It is generally noticed that winter was superior among the seasons with using high, medium and low fertilization

treatments which accompanied with increasing percentages in N uptake, compared with their relevant control treatment by 208, 111 and 63 %, respectively.

-The highest seasonal P uptake during the stand duration indicated the superiority of spring; decreased slightly during autumn; followed by summer and winter seasons.

-The highest P content among the grown alfalfa cultivars was of Ismalia-1 in winter, spring, summer and autumn. Whereas, the lowest P content was for Melesia in winter, spring; Hallma in summer and autumn seasons.

-There were significant differences among all of the applied fertilization treatments which positively affect the seasonal P uptake of alfalfa plants compared to the control (T1) having various magnitudes. Similar trend was found during the four growing seasons. Seasonal P uptake under each fertilization treatment was higher in spring season followed by autumn then summer where the lowest P uptake was produced in winter season.

-Over the grown alfalfa cultivars, the highest combined fertilization treatment (T4) significantly enhanced alfalfa plants which produced the highest P uptake values of 6.309, 10.034, 7.062 and 9.09 kg/fed. in winter, spring, summer and autumn season compared with their control values of

1.447, 2.855, 1.513 and 2.049 for the same corresponding seasons.

-The highest seasonal (combined over the two first years) K uptake during the stand duration indicated the superiority of spring season; decreased slightly during autumn season; followed by summer and winter seasons.

-The highest K content among the grown alfalfa cultivars was in Ismaila-1 in winter, spring, summer and autumn seasons. Whereas, the lowest K content was in Melesia in winter, spring, summer and autumn seasons.

-There were significant differences among all of the applied fertilization treatments which positively affect the seasonal (combined over the first two years) K uptake of alfalfa plants compared to the control (T1) having various magnitudes. Similar trend was found during the four growing seasons. Seasonal (combined over the first two years) K uptake under each fertilization treatment was higher in spring season followed by autumn then summer where the lowest K uptake was produced in winter season.

-Over the grown alfalfa cultivars, the highest combined fertilization treatment (T4) significantly enhanced alfalfa plants which produced the highest K uptake values of 44.375, 74.885, 61.523 and 67.829 kg/fed. of the subsequent

winter, spring, summer and autumn season compared with their control values of 9.386, 25.722, 21.899 and 24.551kg/fed. for the same corresponding seasons.

-The highest season of Zn-uptake during the second year indicated the superiority of winter decreased slightly during autumn followed by spring and summer seasons.

-During winter season, cultivar of Ismailia-1 contained Zn-values higher than those of the other cultivars (Hallma, Melesia, Siriver and Sewa). The highest Zn-uptake content in the growing alfalfa cultivars was in Ismailia-1 in winter and summer, Sewa in spring and autumn season. Whereas, the lowest Zn-uptake was for Hallma in winter, summer and autumn, Melesia in spring season.

-Values of the highest seasons of Mn-uptake during the second year indicated the superiority of summer; decreased slightly during autumn and spring; followed by winter season.

-During summer season, Ismailia-1 cultivar contained Mn-content higher than those of the other cultivars (Hallma, Melesia, Siriver and Sewa). The highest Mn-uptake among the grown alfalfa cultivars was in Ismailia-1 in winter, spring, summer and autumn season. Whereas, the lowest

Mn-uptake was for Melesia in winter, Hallma in spring, summer and autumn seasons.

-Mn-content in seasons of the second year under each fertilization treatment was higher in summer season followed by autumn and spring; where the lowest Mn-uptake was produced in winter season.

-The highest combined fertilization treatment (N<sub>30</sub> P<sub>30</sub> K<sub>40</sub>) significantly enhanced alfalfa plants which produced the highest Mn-uptake values of 0.101, 0.109, 0.100 and 0.110 kg/fed. in the winter, spring, summer and autumn seasons compared with their control values of 0.023, 0.026, 0.037 and 0.027 kg/fed. for the same corresponding seasons.

-Summer season was superior among the seasons of the second year with using high, medium and low fertilization treatments which accompanied with percentages of increase in Mn-uptake compared with their relevant control treatment of 170, 100, 49%, respectively.

- Values of Cu-uptake during the second year indicated the superiority of spring season; decreased slightly during summer; followed by autumn and winter seasons.

-During spring season, Ismailia-1 cultivar contained Cu values higher than those of the other cultivars (Hallma, Melesia, Siriver and Sewa). The highest Cu-uptake among

the grown alfalfa cultivars was Ismailia-1 in winter, spring, summer and autumn season. Whereas, the lowest Cu-uptake was for Hallma in winter, spring, summer and autumn seasons.

- Spring season was superior among the seasons with using high, medium and low fertilization treatments which accompanied with percentages of increase in Cu-uptake compared with their relevant control treatment of 134, 76 and 61%, respectively.

-During autumn season, Ismailia-1 cultivar contained higher Fe than those of the other cultivars (Hallma, Melesia, Siriver and Sewa). The highest cultivar in its Fe-uptake among the grown alfalfa cultivars was Ismailia-1 in winter, spring; summer and autumn seasons. Whereas, the lowest Fe- uptake was for Hallma in winter, spring, summer and autumn seasons.

-Fe-uptake under each fertilization treatment was higher in autumn season followed by winter then spring where the lowest Fe- uptake was produced in summer season.

-The highest combined fertilization treatment (T4) significantly enhanced alfalfa plants which produced the highest Fe- uptake values of 1.473, 1.072, 0.767 and 1.47kg/fed. in winter, spring, summer and autumn season

compared with their control values of 0.266, 0.248, 0.146 and 0.400kg/fed. for the same corresponding seasons.

## **II- The pot experiment:**

- Pot experiment was designed and implemented at the Agricultural Research Station of El-Ismailia Governorate during 2002/2003 and 2003/2004 growing seasons to study the effect of applying Mo as ammonium molybdate on the forage productivity and uptake of N, P, K and Mo of some local and exotic alfalfa cultivars *Medicago sativa* as previously recorded in the field experiment. Sandy soil from Ismailia area and sandy loam (calcareous) soil from Noharia were used.

- Treatments were layed out in a Randomized Complete Block Design (RCBD) in four replications. Two molybdenum treatments were used, 2 Kg Mo /fed which equals to 0.074 g/pot as ammonium molybdate and without ammonium molybdate as a control.

**The most important results could be summarized as follows:**

-Over all seasons, alfalfa cultivars fertilized with molybdenum produced the highest total forage yield (fresh and dry) of the grown alfalfa cultivars as compared with their control (no Molybdenum).



-In the first year with noticeable variable magnitudes between soils, sandy soil produced plants of high fresh weight as compared with calcareous one particularly in spring and summer seasons, while in winter and autumn calcareous soil produced plants of higher fresh weight.

-The local cultivars Ismailia-1 was superior in its forage yield (fresh and dry) followed by Sewa cultivars with significant differences among cultivars when grown on each of the studied soils (sandy and calcareous).

-The three exotic alfalfa cultivars (Hallma, Melesia and Siriver) were inferior in their forage production (fresh and dry) than the local alfalfa cultivars (Sewa and Ismailia-1) with significant differences among each other when grown on each of the two soils (sandy or calcareous) and during the two years of stand duration.

-The application of Mo fertilizer significantly increased the forage yield of alfalfa compared to the control (without Mo) in each of the two types of soil.

-The highest dry forage yield of the studied cultivars was obtained in summer season, and the lowest one was recorded in winter season in sandy soil during the first year of stand duration. Whereas, in calcareous soil the highest dry yield of the tested cultivars was recorded in autumn and

the lowest one was recorded in winter seasons with significant differences as well.

-There was a great response to Mo application in the autumn season in sandy and calcareous soils during the second year with no significant differences between seasons and Mo application in the calcareous soil in the same year. The highest dry yield of the local cultivar Ismalia-1 was in autumn season, and the lowest values of the exotic cultivar Melesia during winter season with no significant differences were obtained with the application of molybdenum. In sandy soil there was significant differences between alfalfa cultivars which grown in the different seasons under the application of molybdenum.

-The lowest leaf/stem ratio during the first year was noticed during winter season of the two soils (sandy and calcareous).

-The local alfalfa cultivars Ismalia-1 and Sewa were superior in their leaf/stem ratio compared to the other cultivars. Whereas, the exotic cultivars Hallma recorded the lowest leaf/stem ratio in the calcareous soil during the second year. Ismalia-1 cultivar exceeded the other cultivars (Hallma, Melesia, Siriver, Sewa) in this studied trait.

-Application of Mo fertilizer significantly increased leaf/stem ratio of alfalfa plants compared to the control (without Mo application) in each of the two soils.

-Plant heights of summer cuts were superior in sandy soil of the two years, while autumn season was the best in the first and second years in the calcareous soil. The two local cultivars produced the tallest plants in the two soils and years. Whereas the shortest plants were produced by the three exotic cultivars in each soil during the two years.

-For either Mo treatment or its control, the descending ranking order for CP content was winter, followed by spring, then autumn followed by summer in sandy soil, while in calcareous soil the descending ranking order for CP content was winter, followed by autumn, then spring followed by summer. This trend was true for either Mo treated or the control treatment. Mo increased CP content in alfalfa plants than untreated ones. This increase was noticed in each of the four growing seasons with various magnitudes. The highest increase in CP content was for Sewa and Hallma in sandy and calcareous soil, respectively.

- In sandy soil, highest effect of Mo application in decreasing CF content was in spring and summer seasons, in calcareous soil, Mo extensively decreased CF content was in winter and summer season. The least decrease in CF content during autumn in sandy and calcareous soil. The less sensitive alfalfa cultivars to be affected by the decrease in CF content due to Mo treatment was Sirever in sandy soil and Melesia in calcareous soil.

- The Mo treatment increased ash content for each of the grown alfalfa cultivars where the average range of ash content was slightly higher in calcareous than in sandy soil. The effect of Mo in increasing ash content was somewhat better for Ismailia-1 in sandy soil, and for Hallma in calcareous soil.

- The wide variations in NFE content due to the applied Mo treatment in alfalfa forage (over cultivars) within the growing seasons and within the soil types of cultivation. In sandy soil, the highest increase in NFE due to applying Mo was noticed in spring while the lowest increase was in winter season. calcareous soil, the highest increase in NFE content was noticed in winter and the lowest increase was recorded in summer. The highest increase in NFE due to the applied Mo was noticed for Melesia cultivar in sandy and

calcareous soil. The average difference of increase in NFE for alfalfa cultivars was higher in calcareous soil compared to sandy soil as a response to Mo treatment.

- Sandy soil, did not show appreciable differences in TDN contents of the obtained alfalfa forage (over the cultivars) as affected by seasonal variation. Seasonal variation exerted a wide range of variation in the TDN of the obtained forage materials from calcareous soil due to the applied Mo treatment. The increase in TDN content due to the applied Mo treatments could be ranked in a descending order as follows: winter, summer, autumn and spring.

### **Nutrient content**

-In the first and second years, calcareous soil produced the highest N-uptake of alfalfa cultivars as compared with sandy one of the all seasons. With the sandy soil, the summer and autumn seasons gave the highest N-uptake in the first and the second years; while the lowest N-uptake was in winter season during all growing seasons with the Mo application. Plants grown on the calcareous soil showed the highest values of N-uptake in the summer and autumn seasons of the first and the second years, respectively, while the lowest N-uptake was in winter

seasons during all growing seasons with the Mo application.

- Nitrogen uptake was relatively higher in autumn season with the sandy and calcareous soils by 625 and 114% ; 621 and 33% than in winter during the first and second years, respectively over all cultivars and Mo application.

-The local Ismailia-1 was the superior in its N-uptake followed by Sewa cultivars with and without Mo application, while the lowest N-uptake was accompanied with the exotic cultivars Hallma, Melesia and Siriver in the growing seasons and on the sandy and calcareous soils.

-Application of Mo fertilizer increased N-uptake of alfalfa compared to without Mo application in each of the two soils. The relative increases of Mo application as compared to without Mo application of the summer seasons in N-uptake were 129 and 144% in the calcareous and sandy soils, respectively.

-Molybdenum application significantly decreased P-uptake by plants grown under sandy and calcareous soils during the tested seasons.

- The local Ismailia-1 was the highest in its P-uptake followed by Sewa cultivar with and without Mo application, while the lowest P-uptake was associated

with the exotic cultivars, i.e., Siriver, Melesia and Hallma.

-Application of Mo fertilizer decreased P-uptake of alfalfa compared to without Mo application in sandy and calcareous soil. The relative decreases with Mo application to without Mo application of the winter season for P-uptake were 79 and 67% in the first year and 66 and 53% in the second year with sandy and calcareous soils, respectively.

-Calcareous soil produced the highest K-uptake of alfalfa cultivars as compared with sandy one in the all seasons. Also, in the calcareous and sandy soils, the summer season gave the highest K-uptake of the first year, while the lowest K-uptake was in winter season for both soils with the Mo application.

-Mo application increases K-uptake of alfalfa plants at all growing seasons in each soil during the first and second years. K-uptake was relatively higher in summer with the sandy and calcareous soils by 957 and 1045% than in winter during the first year. In the second year K uptake was increased by 148 and 64% over all cultivars and Mo application of the spring in the sandy soil and in autumn season with the calcareous soil.

-The lowest K-uptake of the alfalfa cultivars with Mo application was by the exotic cultivars Siriver, Melesia and Hallma in the first and second years with sandy and Siriver, Hallma and Melesia of the calcareous soils. While the highest K-uptake was found in the local cultivars Ismailia-1 followed by the Sewa with the sandy and calcareous soils.

-There was a great response to Mo application in the summer season and sandy soil. Similar trend was observed in the summer and autumn seasons of the first and second years, respectively, in the calcareous soil.

-Mo uptake was increased with Mo application in both soils. Calcareous soil showed higher amounts of Mo uptake resulted from increasing dry matter yield of plants not increasing Mo concentration.

-In the second year, with Mo application the highest Mo-uptake was obtained from the local alfalfa cultivar Ismailia-1 in spring season, with sandy soil and in autumn with the calcareous soil.

-The exotic cultivars, Siriver, Melesia and Hallma contained the lowest Mo-content at four seasons with the sandy and calcareous soils.



-The relative increases with Mo application to without Mo application overall seasons for Mo-uptake were 404 and 400% in the second year with sandy and calcareous soils, respectively.

## **Conclusion and Recommendations**

Generally, local cultivars showed the highest fresh and dry yields and the uptake of all nutrients as compared with exotic, while the exotic cultivars revealed high content of crude protein (CP), ash and TDN.

The best cultivar was Ismailia-1 which showed a superiority in summer as it had the highest CP, ash and TDN, and the lowest CF.

The exotic Melesia in winter was the highest in CP, TDN, EE and the lowest in CF. While in spring the cultivar Siriver showed high values of CP, TDN, and low values of CF.

Plants growing in spring seasons revealed superiority in the following parameters: fresh forage yield, plant height, P uptake, K uptake, and Cu uptake as compared with those of the other seasons.

In winter seasons, there were a superiority of number of shoots, ash, CP, EE, TDN and Zn as compared with the

abovementioned parameters of the plants growing in other seasons.

The behavior of cultivars in sandy and calcareous soils were studied and plants grown in calcareous soil were the highest in all studied parameters as compared with those grown in sandy soil.

In sandy soil, Hallma (exotic cultivar) reveals a superiority in CP, ash, and EE and Melesia cultivar was the highest in its content of CF, NFE and TDN. In the case of calcareous soil, Siriver was the highest cultivar in its content of CP, ash, EE and TDN, and was the lowest in CF.

Cultivation of local cultivars could be recommended, particularly Ismailia-1 in summer season when the high dry and forage yields, beside the highest nutrient contents as well as CP, and TDN were concerned.

Growing the exotic cultivars (i.e., Hallma, Melesia and Siriver) under the local environment may alter and modify their characteristics toward the best