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Effect of Potassium Foliar Applications on Productivity and Quality of Mono-Cut Egyptian Clover under Saline Soil

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SEVERAL field and laboratory experiments were carried out to study the effect of different potassium (potassien) rates as foliar application on growth traits, yield and yield components of mono-cut Egyptian clover (variety Giza 1). Two field experiments were conducted at the Experimental Farm Station of El-Serw, Damietta Governorate, Mansoura, Agriculture Research Center (salt affected soil) and tow laboratory experiments at the Forage Crops Res. Depart., Field Crops Res. Inst., ARC, Giza, during 2015/2016 and 2016/2017 seasons.

A completely randomized blocks design with six replicates was used in the field experiments and a completely randomized design with three replicates was used in the laboratory experiments. Results revealed that all the levels of potassium foliar application treatments (0.5, 1 and 2L fad^{-1} of potassien) showed superiority over the control treatment (without foliar potassium). Foliar treatment with 2L fad^{-1} recorded the highest values of all studied growth traits, i.e, plant height, no.of branches $plant^{-1}$, leaves/stem ratio, fresh and dry forage yields compared with control. The maximum values of the above mentioned traits were 66.33cm, 5.33 no.of branches $plant^{-1}$, 0.593%, 14.05ton fad^{-1} and 3.18ton fad^{-1}, respectively. Moreover the highest number of head/m^2, no. of seeds/head, the weight of 1000 seeds and seed yield kg fad^{-1} were obtained by increasing the concentration or rate of potassien application up to 2L fad^{-1}. In addition potassien foliar applications lead to improving forages quality by increasing the content of N, P & K and protein and carbohydrate %. Results showed that application of potassien rates had a positive effects on germination %, shoot and radical lengths, dry seedling weight, seedling vigor.

Keywords: Mono-cut clover, Potassien rates, Salt-affected soil, Forage and Seed yields, Chemical composition.

Introduction

Egyptian clover "berseem" (*Trifolium alexandrinum* L) is the main winter forage legume crop. In Egypt it occupies about one million hectare about one third of the cultivated area in Egypt which satisfies animal population requirements in winter season. Berseem is a major seed export crop (more than 12000 tons) (El-Nahrawy, 2005).

One of the major difficulties facing berseem cultivation is the low productivity of seeds. Several factors affect berseem seed production among them; number of cuts, length of the growth period before flowering, drought, soil salinity, whether conditions and availability of pollinators (Geweifel & Rammah, 1990).

Salinity is a major a biotic stress which adversely affect plant processes at physiological, biochemical and molecular levels and reduces plant productivity (Tester & Davenport, 2003 and Munns, 2002). It is well known that both high sodium chloride and high pH level cause K shortage. An alternative strategy to cope with salinity could; thus, to attempt to supplement K where the growth medium is known to be or may become saline at some time during the crop growth cycle (Satti & Yahyai, 1995).

It is well accepted that K concentration is much

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less in plants grown with high sodium chloride; therefore, supplementary K application could enhance the K concentration within the plants. These results suggest that supplementary K can improve plant growth, yield and its quality of plant grown under saline conditions (Greenway & Munns, 1980).

Kaya et al. (2001) found that adding of (K) mitigated the harmful effect of high salt. The agricultural system is tightly linked with the fertilizer input and thus the judicious application of the fertility is expected to lead positive effects in the soil salinity effects (Khan et al., 2014)

Potassium plays a vital role in increasing the yield and quality of plant. Potassium is essential in maintenance of osmotic potential and water uptake and had a positive effect on stomatal closure which enhance tolerance to water stress (Epstein, 1972). Moreover, Aown et al. (2012) reported that potassium has a key role in improving the plant tolerance to stress conditions. Many physiological processes of plants affecting plant growth and yield such as photosynthesis, activation of enzymes, plant water relation and assimilation are affected by potassium supplement (Pettigrew, 2008). It significantly affect protein synthesis, enzyme activation, osmoregulation, photosynthesis, stomatal movement, phloem transport, energy transfer, cation – anion balance and stress resistance (Marschner, 2012).

Foliar application of (K) as a fertilizer application is considered active way and lead to increases the absorption of potassium and other nutrients, in addition to enhancing the nutrient use efficiency and enhance the crop growth under saline soil by decreasing the salts accumulation and by maintaining the optimum nutrient level in the root zone of plants (Mohamed et al., 2010). Mostly foliar applications of micronutrients are applied, but it can be used for the macronutrients such as N, P and K but these macro nutrients are required by crops in large amounts, thus foliar application, two times, complete the fertilizer requirements of macronutrients of crop plants (Abid et al., 2016).

Nutrient uptake and transport to the edible parts of plants can be increased by fertilizer foliar application to leaf. Foliar fertilization is one of the most effective and safe approaches to raise essential nutrients in crop. Leaf applied substances on enter the leaf either by penetration of the cuticle or via the stomata pathway (Amir et al., 2011).

The present stud aiming to investigate the effect of (K) foliar application as potassien under saline soil on the forage yield, quality as well as seed yield of mon-cut Egyptian clover variety Giza 1.

Materials and Methods

The present work includes two field and two laboratory experiments to investigate the effect of potassien foliar applications on forage yield and quality as well as seed yield of mono-cut Egyptian clover variety Giza 1. Potassien (32% K_2O and 8% P_2O_2) was used at four rates (control, 0.5, 1 and 2L fad^{-1}). Each rate was dissolved in 200L water fad^{-1} and sprayed twice at 30 and 60 days from planting date.

Field experiments

Two field experiments were conducted at the Experimental Farm Station of El-Serw, Damietta Governorate, Mansoura, Agriculture Research Center. A completely randomized blocks design with six replicates was used in the field experiments. Plot size was 4 x 4m = 16m^2, three replicates were devoted for forage yield and the other three for seed yield. The soil analyses of the experimental site was done according to Cottenie et al. (1982) and are shown in Table 1.

The Meteorological data for North of Delta region in 2015/2016 and 2016/2017 winter seasons are shown in Table 2

The scientific name of the soil salinity and pH classes based on USDA (2002): Slightly saline and slightly alkaline.

The preceding crop was rice for the two seasons. Recommended agricultural practices were done, i.e., recommended fertilizer rates, Superphosphate at rate 150kg fad^{-1} (15.5% P_2O_5) was applied during soil tillage and potassium 24kg fad^{-1} K_2O in the form of potassium sulphate (48% KO_2) before sowing. Furthermore, Nitrogen fertilizer at rate 15kg fad^{-1} in the form of ammonium nitrate (33.5%N) was applied before the second irrigation. Giza 1 seeds were sown at a rate of 20kg fad^{-1} on 17 and 21 November in 2015 and 2016, respectively. The six experimental replicates were divided into two equal parts; the first three were for estimating forage yield and its components, while the second three was left to estimate seed yield.

TABLE 1: Physical and chemical analysis of the soil before conducting the experiment (means of the two seasons).

Soil characteristics	Means of both seasons
Particle size distribution %	
Coarse sand	1.44
Fine sand	10.35
Silt	22.26
Clay	65.95
Textural class	Clayey
Chemical properties	
pH (suspension 1:2.5)	7.6
EC dS m^{-1} (saturated paste extract)	5.88
Organic matter (%)	0.86
$CaCo_3$ (%)	1.34
Available macronutriments (ppm)	
N	32
P	7.94
K	201.3

TABLE 2. Meteorological data* for North of Delta region in 2015/2016 and 2016/2017 winter seasons.

Month	2015/2016			
	T.max (ºC)	T.min (ºC)	T. average	Rain fall (mm)
November	24.8	19.1	21.95	4.0
December	20.1	14.6	17.35	6.7
January	17.7	9.3	13.5	9.1
February	19.1	13.2	16.15	8.1
March	22.1	15.2	18.65	0.4
April	24.8	18.6	21.7	2.9
	2016/2017			
November	24.5	19.1	21.8	4.0
December	18.7	12.7	15.7	6.7
January	17.2	10.7	13.9	12.3
February	18.2	12.2	15.2	4.7
March	20.6	14.7	17.65	0.1
April	17.1	16.1	16.6	0.4

T.max= Maximum temperature; T.Min = Minimum temperature; W.S.=Wind speed; R.H.=Relative humidity.

Data recorded at harvest

Ten guarded plants were randomly chosen from each plot before cutting to estimate the following :

1. Plant height (cm): Measured in cm from ground surface to the top of the plant .
2. Number of branches $plant^{-1}$.
3. Leaves:$stem^{-1}$ ratio: By dividing the dry weight of leaves on dry weight of stem.
4. Fresh forage yield (ton fad^{-1}): Plots were hand clipped and weighed in kg $plot^{-1}$, then adjusted into ton fad^{-1}. (Faddan = 0.42 hectar).
5. Dry forage yield (ton fad^{-1}): Sub samples of 100g were dried at 105^0C to a constant weight and dry matter percentage was estimated. The dry forage yield (ton fad^{-1}) was calculated by multiplying fresh forage weight (ton fad^{-1}) with dry matter percentage (DM%).
6. Number of heads m^{-2}.
7. Number of seeds $head^{-1}$.
8. Weight of 1000 seeds.
9. Seed yield kg fad^{-1}.

Chemical composition

Plant samples which collected from each plot were weighed and oven dried at 70^0C for 48h up to the constant weight, ground and prepared and following the conventional methods recommended by the Association of the Official Agricultural Chemists (A.O.A.C., 1999) to determine crude protein percentage (CP) %, carbohydrate % and to determine N, P and K contents methods describe by Cottenie et.al. (1982) were used.

Laboratory experiments

At the Laboratory of Forage Crops Res. Depart., Field Crops Res. Inst., ARC, Giza, Two experiments were conducted during 2016 and 2017 seasons after field experiments to investigate the effect of potassium foliar application on seeds which collected from the above mentioned field experiments. A completely randomized design with three replicates was used in the laboratory experiments. Fifty seeds were germinated in covered, sterilized, Petri dishes containing Whatman no.1 filter paper **.**

Data recorded

Germination percentage = n/N x 100

where, n is the number of germinated seeds, N is the number of total seeds.

1- Shoot and Radical length: Ten seedlings were randomly selected and measured shoot and radical length .
2- Dry weight of seedling: The seedlings were put into paper packet separately and placed into the preheated oven 70^0C up to the constant weight.
3- Seedling vigor index = Germination percentage X seedling dry weight.

Statistical analysis

Data were statistically analyzed according to Snedecor & Cochran (1980) and treatment means were compared by least significant difference test (LSD) at 0.05 level of significance. Bartlett,s test was done to test the homogeneity of error variance. The test was not significant for all assessed traits, so, the two seasons data were combined.

Results and Discussion

Field experiments

Data presented in Tables 3 and 4 showed the effect of potassien foliar applications on forage yield and some vegetative growth traits of mono-cut Egyptian clover (variety Giza 1), i.e., plant height, number of branches, leaves stem^{-1} ratio, fresh yield and dry yield, and its effect on seed yield traits, i.e., number of seeds head^{-1}, number of heads m^{-2}, weight of 1000 seeds and seed yield kg fad^{-1}.

Growth traits

Data in Table 3 indicated that there were significant differences between potassien treatments on plant height, number of branches and leaves stem^{-1} ratio. The highest values of these growth traits were recorded with the highest rate of potassien 2L fad^{-1} which was significantly higher than the other treatments. Relative increases percentages in growth traits, as compared to the control, were 39.09, 60.06 and 40.19% for the previous growth traits, respectively. These results could be attributed to the role of potassium in increasing growth of mono-cut clover. These results are in agrement with those reported by Thalooth et al. (2006) on mungbean and Aboelgoud et al. (2015) on multi-cut clover (berseem). Potassium has been reported leading to increasing growth during the productive phase in some crops, even if the potassium content in the soil was sufficient to maintain good vegetative growth (Srinivasa et al., 2010). The increases of values of growth traits due to the basal and foliar applications of (K) might have an important role in photosynthesis and its possible role in plant metabolism involved activation of many of enzymes. Due to the positive effects of potassium in the regulation of osmotic pressure and increasing the pressure of turgor on plant cells resistance and its elongation, increasing the amount of potassium by spraying plants directly had a positive effect on plant height, enhance the turgor pressure, loading and transport of nutrients and water balance of plant. Potassium fertilization is associated with increasing crop growth due to the positive effect of this nutrient (Asgharipour & Heidari, 2011).

Forage yield and its components

Results in Table 3 revealed that both fresh and dry forage yields were significantly influenced by potassien foliar applications as compared with the control. Plants received the highest rate of potassien (2L fad^{-1}) gave the highest values of fresh and dry forage yields which surpassed the untreated plants (control) by 37.11 and 40.7%.

Results also showed that there was positive and significant increases in both fresh and dry forage yields by increasing the rate of potassien application.

This indicate that (K) shortage is only or partly, responsible for reduce of yield and productivity under salinity conditions. This may be attributed to potassium vital role in the nutrition and production of forage legumes (Misra et al., 2012). Aboelgoud et al. (2015) reported that adding potassium fertilizer in high portion markedly lead to increasing forage yield on mono-cut Egyptian clover. Keyvan et al. (2015) found that three times foliar application of potassium gave the highest yield of sorghum forage (40.43ton ha^{-1}) compared with that without foliar application (30.13ton ha^{-1}).

Seed yield and its components

Data presented in Table 4 showed clearly the positive and significant effects of potassien foliar applications on seed yield and its main components such as number of seeds $head^{-1}$, weight of 1000 seeds and number of heads m^{-2} compared with the control treatment.

Results also showed that seed yield and its component traits were significantly increased by increasing the rate of potassien application.

The highest values of seed yield and the studied seed traits were recorded with the highest rate of potassien foliar application. The increases in seed yield amounted 15.15, 25.76 and 44.37% of the control with the foliar application of 0.5, 1.0 and 2L fad^{-1}, respectively. Similar increases were found with the investigated seed traits, i.e., No.of seeds $head^{-1}$, weight of 1000 seeds and No. of heads m^{-2}. These increases amounted 16.41, 26.42 and 43.56% in No. of seeds $head^{-1}$ and 6.76, 10.98 and 18.31% in weight of 1000 seed and 15.15, 25.76 and 44.37% for No. of heads m^{-2} of the control by foliar application of 0.5, 1.0 and 2L fad^{-1}, respectively.

The possible reason for these improvement in seed yield and other seed traits could be due to the positive and significant increases in vegetative growth traits of Fhal clover as previously discussed in Table 4. The increases in No. of branches leads to more production of heads and great No. of seeds. Moreover, the increases in vegetative growth lead to heavier seeds (weight of 1000 seed). These results are in harmonious with those reported by Beena et al. (2011) on berseem and Thalooth et al. (2006) on mungbean and Aboelgoud et al. (2015) on multi-cut berseem variety "Serw 1". Such enhancement effect could be attributed to the favorable effect of this nutrient on metabolism and biological activity and its stimulating affection photosynynthetic pigments and enzyme activity which in turn increase vegetative growth traits of plants (Tausz et al., 2004).

Total contents of macronutrients, protein% and carbohydrate %

Results in Table 5 showed clearly the positive and significant effects of potassien foliar applications on N, P and K uptake. Increasing rate of potassien increased the above macronutrients to different extents. The highest values of N, P and K were recorded with the highest rate of potassien (2L fad^{-1}). These results are in harmony with those reported by Jamriski (2000) on berseem, Abou –Baker et al. (2011) on bean plants, Maria et al. (2004) on white clover and Ibrahim et al. (2015) on Fahl berseem . These reports indicate that potassium had significant effect on yield and quality of studied crops. Abou- Baker et al. (2011) explained this positive effect of potassien could be attributed to the role of potassium in water regulation, intake and increase water use efficiency.

In respect to the effect of potassien foliar applications on protein and carbohydrate %, results revealed that protein contents were significantly increased by increasing the rate of potassien while the opposite was true in case of carbohydrate.

Laboratory experiment

The laboratory experiments were conducted on the seeds harvested from the above mentioned field experiments of potassien foliar application on mon- cut Egyptian clover (variety Giza 1). These laboratory experiments aimed to determine the effect of potassien foliar application on the viability and quality of seeds produced from mon-cut Egyptian clover (variety Giza 1) plants.

Resuts in Table 6 showed that germination % and seedling traits were significantly affected to different extents by potassien foliar applications.

The highest values of germination %, shoot and radical lengthes, seedling dry weight and seedling vigor were recorded with the highest rate of potassien foliar application. This superiority could be attributed to the superiority of 1000 seeds weight as shown in Table 5. These results are in consonant with those reported by Aboelgoud et al. (2015) on Egyptian clover variety "Serw 1" and Ibrahim et al. (2015) on mono-cut Egyptian clover variety Giza1.

TTABLE 3. Effect of potassium foliar applications on forage yield and its components of mono-cut Egyptian clover (combined analysis across the two seasons 2015/2016 and 2016/2017).

Potassien rates	Plant height (cm)	No.of branches plant^{-1}	Leaves stems ratio	Fresh yield (ton fad^{-1})	Dry yield (ton fad^{-1})
Control	47.69	3.33	0.423	10.25	2.26
0.5	52.33	3.67	0.483	10.85	2.43
1	61.33	5.00	0.527	12.65	2.68
2	66.33	5.33	0.593	14.05	3.18
L.S.D.	3.78	0.75	0.017	0.378	0.189

Control (without potassien) , 0.5, 1 and 2L fad^{-1} are rates of potassien.

TABLE 4. Effect of potassium foliar applications on seed yield and its components of mono-cut Egyptian clover (combined analysis across the two seasons 2015/2016 and 2016/2017).

Potassien rates	No.of seeds head^{-1}	Weight of 1000 seeds (g)	No. heads m^{-2}	Seed yield kg fad^{-1}
Control	46.67	3.55	404.67	154
0.5	54.33	3.79	509.67	177.33
1	59.0	3.94	631.0	193.67
2	67.0	4.2	680.0	222.33
L.S.D.	4.46	0.19	30.44	14.02

Control (without potassien), 0.5, 1 and 2L fad^{-1} are rates of potassien .

TABLE 5. Effect of potassium foliar applications on total contents of macronutrients (mg L^{-1}) and protein % and carbohydrate % (combined analysis across the two seasons 2015/2016 and 2016/2017).

Potassien rates	N uptake	P uptake	K uptake	Protein %	Carbohydrate %
Control	63.37	6.267	34.23	17.54	39.37
0.5	64.67	6.813	36.45	17.82	37.22
1	66.1	7.243	36.76	18.29	33.24
2	67.77	7.713	36.98	18.67	32.08
L.S.D.	0.222	0.274	0.206	0.204	0.314

Control (without potassien), 0.5, 1 and 2L fad^{-1} are rates of potassien.

TABLE 6 . Effect of potassium foliar application on germination and seedling traits (combined analysis across the two seasons).

Potassien rates	Germination %	Shoot length (cm)	Radical length (cm)	Seedling dry weight (g)	Seedling vigor
Control	91.62	1.633	0.533	0.001	0.092
0.5	94.29	2.200	0.967	0.002	0.189
1	95.19	2.967	1.367	0.002	0.192
2	97.19	3.600	2.633	0.004	0.389
L.S.D.	0.655	0.340	0.273	0.001	0.095

Control (without potassien), 0.5, 1 and 2L fad^{-1} are rates of potassien.

Conclusion

The results of the this study on mono-cut Egyptian clover (variety Giza1), foliar application of K (potassien) fertilizer within the sufficiency range (2L fad^{-1}) was beneficial in alleviating the effect of salinity on the forage yield and vegetative growth of Giza 1 and lead to increasing seed yield and its quality.

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تأثير الرش الورقي بالبوتاسين على أنتاجية وجودة البرسيم الفحل في الأراضي الملحيه

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالسرو (أراضي متأثرة بالملوحة) التابعه لمركز البحوث الزراعيه بمحافظة دمياط خلال موسمي (2016/2015 - 2017/2016)، وتجربتان معمليتان بقسم بحوث محاصيل العلف معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية بالجيزة، بهدف دراسة تأثير ثلاث مستويات من الرش الورقي بالبوتاسيوم بتركيز (0.5، 1 و 2 لتر/فدان) في صورة بوتاسين بالإضافه إلى معاملة المقارنة (بدون رش) على انتاجية وجودة حاصل العلف الأخضر والبذور لمحصول البرسيم صنف جيزة 1 (ذات حشة واحده). تم أذابة كل تركيز في 200 لتر ماء/فدان. تم الرش الورقي مرتين بعد 30 و60 يوم من الزراعة.

وأوضحت الدراسه النتائج التالية:

زاد حاصل العلف الأخضر ومكوناتة زيادة معنوية بزيادة التسميد الورقي بالبوتاسين من0.5 - 2 لتر/فدان مقارنة بمعاملة المقارنه في كلا الموسمين.

زاد كلا من طول النبات وعدد الأفرع للنبات ونسبة وزن الأوراق للسيقان وكذلك الوزن الغض والجاف لحاصل العلف للبرسيم ذات الحشه الواحده بمعاملات الرش الورقي، وقد تفوقت معاملة الرش بتركيز 2 لتر/فدان على باقي المعاملات تحت الدراسة.

ارتفع محتوى البوتاسيوم والفوسفور والنيتروجين وكذلك نسبة البروتين بينما انخفضت نسبة الكربوهيدرات مع زيادة معدل البوتاسين من 0.5 إلى 2 لتر/فدان رش ورقي .

زاد حاصل البذرة ومكوناته من عدد الكبسولات في المتر المربع ووزن الالف بذرة وكذلك حاصل البذور للفدان مع الرش الورقي بالبوتاسين وكانت أعلى القيم مع الرش بتركيز 2 لتر/فدان.

زادت جودة البذور المتحصل عليها بإرتفاع نسبة انباتها وزيادة طول الريشة والجذيروالوزن الجاف وقوة البادرة بالرش بالبوتاسين وكانت أعلى القيم عند الرش بأعلى تركيز (2 لتر/فدان) .

أظهرت الدراسه وجود إستجابة واضحه برش البوتاسين على المحصول المنزرع في ألاراضي المتأثرة بالأملاح لوجود نقص ملحوظ لهذا العنصر في مثل هذة الأراضي، لذلك ينصح بالرش بالبوتاسين على محصول البرسيم الفحل.