Response of Lentil to Foliar Application of Potassium Phosphate under Different Irrigation

Fathy M. F. Abdel-Motagally
Agronomy Department, Faculty of Agriculture, Assiut University, Egypt

Abstract:

Two field experiments were conducted during 2011/2012 and 2012/2013 seasons at Agron. Dept. Farm., Fac. Agric., Assiut Univ., to study the response of lentil to foliar application of potassium phosphate under different irrigation treatments. The results showed that:

Irrigation treatments had a highly significant influence on the all studied traits except harvest index in both seasons. So, plants had one irrigation (I_1) at flowering (after first irrigation, Mohaya) produced the highest mean values of all studied traits except harvest index in both seasons. Also, plants had twice of foliar application of potassium phosphate produced the highest mean values of all studied traits.

The interaction between irrigation management and foliar application of potassium phosphate had a significant effect on all studied traits except harvest index and protein % in both seasons. Plants had received twice of foliar application of potassium phosphate with I_1 treatment produced the highest mean values of plant height (47.34 and 45.36 cm), number of branches plant^{-1} (4.52 and 4.25), number of pods plant^{-1} (46.25 and 44.35), seed yield plant^{-1} (1.46 and 1.42 g), seed index (26.57 and 27.05 g), seed yield plot^{-1} (1.78 and 1.76 kg), straw yield plot^{-1} (6.43 and 6.65 kg), and seed yield fed.$^{-1}$ (712.0 and 704.0 kg) in the first and second seasons, respectively.

Keywords: Lentil, foliar application, potassium phosphate and irrigation management.

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Referees: Prof.Ragab A. E. Dawood Prof. Eman M. Taha

Introduction:

Lentil (*Lens culinaris*, Medic) is one of the oldest known leguminous foods rich in protein (22-25%). So, it is the best cheapest sources of vegetable protein in Egypt and provides a good source of minerals and essential amino acids for human consumption as well as its straw is valuable animal feed. In Egypt, many devoted attempts to improve lentil quality and quantity to cover insufficient consumption. These may be achieved via nutrition which had a great effect on lentil productivity. Increasing lentil production is one of the major targets of the agricultural policy that can be realized by increasing both lentil cultivated area and productivity. The lentil area can be expanded in reclaimed soils under irrigated conditions outside the Nile Valley and by planting lentil as a catch crop before cotton in the old land (Hamdi and Zakia Ezzat, 1998). In Upper Egypt, farmers usually sow lentil in early winter (November). Therefore, the reproductive growth stage of the crop coincides with increasing water deficits and high temperatures from April onwards. Alleviating soil moisture stress during the critical crop growth stages is the key to improved production. Supplemental irrigation is a highly efficient option to achieve this strategic goal by providing the crop with the needed amount of water at the required time (Oweis and Hachum, 2001).

The importance of balance application of plant essential elements is well recognized throughout the world. Fertilizers management is a major factor responsible for poor lentil productivity and the plants response to the application of fertilizers depends on the available nutrient status of soils (Singh and Marok 1981). Potassium plays many major roles in the physiological processes in plants such as transportation of solutes, stomata's movement, and enzymes activation in plants, despite the few published studies on potassium effects on lentil. In Egypt, El-Desoky *et al*. (1993) reported that the application of 90 kg K_2O fed. $^{-1}$ increased significantly lentil yield.

Also, phosphorus is one of the essential elements for optimum growth of lentil plants. It plays an important role in the establishment of legumes seedlings, root and shoot growth and it is especially needed for nitrogen fixation by Rhizobium bacteria. It had played important role in metabolic processes such as the conversion of sugar into starch and cellulose. The phenomena of P fixation and precipitation in the form of insoluble calcium phosphate compounds in soils (pH above 7) led to reduce in soil available P. A sufficient P supply of lentil is decisive to a considerable extent both yield and quality. Over supply as well as undersupply of nutrients, in particular of P means a reduction of quality. This deficiency is particularly revered to many factors such as the intensive cropping system in Egyptian agriculture and the reduction in the amount of Nile alluvium after the construction of Aswan High Dam. Before the construction of the high dame in 1966, lentil was cultivated as a Basin crop with low amount of water. Nowadays, lentil has been cultivated under perennial irrigation system. No fertilization was applied depending on the large amount of mud sediment from the annual flood. Average lentil yield declined under the new irrigation system after the High Dame started to function, because the annual supply of potassium from flood stopped too. Recently, phosphorus and potassium as foliar application are particularly useful under Egyptian soil conditions where, it suffers greatly from alkalinity, therefore, most elements fixed and become unavailable to plant uptake. In view of this, present study was designed to see the effect of potassium phosphate on lentil yield and quality grows under different irrigation managements.

Materials and Methods:

The present study was carried out at Experimental Farm, Agronomy Department, Faculty of Agriculture, Assiut University, Assiut, Egypt during 2011/2012 and 2012/2013 seasons to investigate the response of lentil crop to foliar application of potassium phosphate under two irrigation managements. Physical and chemical properties of the experimental soil were determined before sowing and presented in Table (1), according to methods described by Jackson 1973. The experiment was randomized complete block design (RCBD) using strip-plot arranged with three replicates. Irrigation managements were applied after first irrigation (Mohaya) as: no irrigation, (I_0) and one irrigation (I_1) at flowering. Irrigation frequency treatments were arranged as main strip and foliar application of K and P fertilizers (potassium phosphate) were assigned to sub-plots. Lentil cultivar Giza-9 with seeding rate at 60 kg fed.$^{-1}$ was used and inoculated with strain of Rhizobium (*Rhizobium leguminosarum*, Vulgaris.). Sowing dates were on 10th and 15th of November in the first and second seasons, respectively. Activating dose of 15 kg N fed.$^{-1}$ as ammonium nitrate (33.5% N) was added to all plots at sowing. The plot area was 10.5 m^2. The foliar application of phosphous and potassium were applied in the form of potassium phosphate solution (30% P_2O_5 and 20% K_2O) at level (400 L fed.$^{-1}$) containing 490 ppm phosphous (P) and 622 ppm potassium (K). Treatments were carried out once at 60 days after planting or twice at 60 and 90 days after planting.

Table (1): Physical and chemical properties of a representative soil samples.

Traits	2011/2012*	2012/2013*
Particle size distribution		
Silt (%)	27.4	27.3
Sand (%)	24.3	25.2
Clay (%)	48.3	47.5
Texture	Clay	Clay
Organic matter (%)	1.75	1.72
Field capacity (%)	42.8	43.2
ECe (dS/m)	0.74	0.77
pH (1:1 suspension)	8.2	8.1
Total nitrogen (%)	0.72	0.69
$CaCO_3$ %	3.4	3.5
Extractable P (ppm)	8.2	8.3
Extractable K (ppm)	121	119

*Each value represents the mean of three replicates

Plants control was sprayed with tap water and spreading agent. All cultural practices were applied as recommended for lentil production in Upper Egypt except the treatments under investigation. The preceded crop was maize in both seasons. At maturity sample of ten guarded plants from each sub-plot was taken at random and the following data were determined: plant height (cm), number of branches plant^{-1}, number of pods plant^{-1} and seed yield plant^{-1} (g). At harvest, all plants grown in plot from each treatment were taken to determine: seed yield plot^{-1} (kg), seed yield fed.$^{-1}$ (kg), straw yield plot^{-1} (kg), seed index (1000-seed weight, g) and harvest index as seed yield/ground biomass. Protein (%): Total nitrogen in seeds was determining using Micro-Kjeldahl method as described by A.O.A.C. (1995) and protein % was calculated by multiplying nitrogen percentage by a factor of 6.25. Analysis of variance was performed on the data of two growing seasons according to Gomez and Gomez (1984). The least significant difference (L.S.D.) test at the 5% level of probability was used to compare the difference among means.

Results and Discussion:

The results of this study concerned with the effect of irrigation frequency, foliar application of potassium phosphate and their interactions on yield and its components of lentil were discussed as follows:

A- Effect of irrigation

Data (Tables 2 and 3) show that irrigation treatments had a highly significant influence on the all studied traits except harvest index in both seasons. The data reveal that plants had received one irrigation (I_1) at flowering produced the highest mean values of plant height (42.38 and 42.45 cm), number of branches plant^{-1} (4.13 and 4.47), number of pods plant^{-1} (41.26 and 36.42), seed yield plant^{-1} (1.32 and 1.22 g), seed index (26.09 and 25.45 g), seed yield plot^{-1} (1.42 and 1.41 kg), straw yield plot^{-1} (5.87 and 5.74 kg) and seed yield fed.$^{-1}$ (568.0 and 560.0 kg) in the first and second seasons, respectively. On the other hand, the highest mean values of protein percentage (22.48 and 22.23%) were obtained from plants received (I_0), as well as the lowest ones (21.12 and 21.08%) were obtained from plants received (I_1) in the first and second seasons, respectively. Since the reduction in water supply forced the plant metabolism to increase the protein synthesis in seeds. The increase in yield and its components of lentil were mainly due to over all improvement of growth and development of plants because of timely availability of soil moisture. El-Desoky *et al.* (1993) indicated that irrigation during flowering and pod-filling stages increased pod number and seed yield of lentil.

These results are in agreement with those obtained by Kamel *et al.* (1990), Tomar and Singh (1991), Kumar *et al.* (1992), Rathore *et al.* (1992), El-Far (1994) and Harb (1994) who found that decrease water supply and nutrients which reflected on decrease in plant growth, that it was explain to continuing of water lack starting from developing flowers primordial till ovules fertilization may be led to the low appearance of florets primordial and decrease fertile flowers which in turn reduced number of pods plant^{-1} and seed yield fed.$^{-1}$. On the other hand, sufficient water irrigation increased plant height, number of branches plant^{-1}

and dry weight plant^{-1} which led to increase number and weight of pods plant^{-1} and seed yield. Gendy *et al*. (1995) stated that increase in water supply caused an increase in vegetative growth by increasing cell division and elongation followed by increasing plant height. In contrary, decreased seed set on the main stem and lateral branches as a result an increase in plant height which reduce the activity of lateral buds and consequently reduced the ability of the plants to produce more branches. Such increase could be attributed to the increase in pod number plant^{-1} and its high seed index value.

B- Effect of foliar application of potassium phosphate

Illustrated data in Tables 2 and 3 indicate that foliar application of potassium phosphate had a significant effect on all studied traits except harvest index and protein % in both seasons. The data reveal that plants received the twice of potassium phosphate produced the highest mean values of plant height (46.56 and 45.23 cm), number of branches plant^{-1} (4.26 and 4.16), number of pods plant^{-1} (44.57 and 43.26), seed yield plant^{-1} (1.43 and 1.41 g), seed index (26.84 and 25.62), seed yield plot^{-1} (1.66 and 1.63 kg), straw yield plot^{-1} (6.46 and 6.28 kg) and seed yield fed.$^{-1}$ (644.0 and 652.0 kg) in the first and second seasons, respectively.

Here, the results indicated that increased seed yield due to the fact that K increased the consumptive used of water and water use efficiency, reflecting more root extension and more soil moisture utilization. Moreover, the positive effect of phosphorus and potassium may be to its role as activator or coenzymes in all vital biosynthetic processes in plant such as chlorophyll synthesis as well as the cumulative effect of phosphorus on the processes of cell division and balanced nutrition.

These results are similar with those observed by Bakheit *et al*. (1989), El-Desoky *et al*. (1993), El-Far (1994) and Zafar *et al*. (2003). Moreover, Azad and Gill (1989) found that lentil response to phosphorus application was greater when applied to soil of low available phosphorus level. Contrary, Teama (1994) reported that potassium fertilization had no significant effect on lentils yield as a main factor. It seemed that potassium concentration is not a limiting factor in lentil production in the particular soil type of the experimental site.

C- Effect of interaction between irrigation and foliar application of potassium phosphate

Data in Tables 2 and 3 reveal that the interaction between irrigation management and foliar application of potassium phosphate had a significant effect on all studied traits except harvest index and protein % in both seasons. The data reveal that plants had received the twice of potassium phosphate with I_1 irrigation produced the highest mean values plant height (47.34 and 45.36 cm), number of branches plant^{-1} (4.52 and 4.25), number of pods plant^{-1} (46.25 and 44.35), seed yield plant^{-1} (1.46 and 1.42 g), seed index (26.57 and 27.05 g), seed yield plot^{-1} (1.78 and 1.76 kg), straw yield plot^{-1} (6.43 and 6.65 kg) and seed yield fed.$^{-1}$ (712.0 and 704.0 kg) in the first and second seasons, respectively. The application of P fertilizer can improve plant growth considerably under drought conditions. Phosphorus improves the root growth and maintains high leaf water potential. The improved root growth results in improved water and nutrient uptake and increases the activity of nitrate reductase which improves the assimilation of nitrate under drought condition. Phosphorus also maintains the cell turgidity by maintaining the high leaf water potential which in turn increases the stomatal conductance and photosynthetic rate under drought. The positive effects of P on plant growth under drought have been attributed to an increase in stomatal conductance, photosynthesis, higher cell-membrane stability, water relations and drought tolerance. An important approach for increasing P uptake involves taking advantage of the symbiosis between the roots and mycorrhizae, the latter of which enhance either the growth or resistance of plants subjected to drought. These results are strongly in agreement with those obtained by Attia (1988), Lal *et al*. (1988), Greco and Cavagnaro (1991), Singh *et al*. (1992) Shah *et al*. (2000), and Anaam *et al*. (2003) who found that all interactions between cultivars, irrigation and phosphorus fertilizer exerted a highly significant effect on all studied traits except for protein%.

Conclusions:

From the results of this experiment, it could be concluded that, under the same conditions lentil yield could be maximized by applying twice foliar application potassium phosphate and irrigated plants at Mohaya and at flowering.

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أستجابة العدس للتسميد الورقى بفوسفات البوتاسيوم تحت معاملات رى مختلفة

فتحى محمد فتحى عبد المتجلى

قسم المحاصيل – كلية الزراعة – جامعة اسيوط

الملخص:

أجريت تجربتان حقليتان بمزرعة تجارب قسم المحاصيل كلية الزراعة بجامعة أسيوط خلال موسمى الزراعة ٢٠١٢/٢٠١١و ٢٠١٣/٢٠١٢ لدراسه استجابه العدس للتسميد الورقى بفوسفات البوتاسيوم تحت معاملات رى مختلفه وأظهرت النتائج مايلى :

-كان تاثيرالري معنويا لكل الصفات المدروسه ماعدا معامل الحصاد حيث أدى أعطاء النباتات ريه عند التزهير بعد الريه الاولى (المحاياه) الى زيادة معنويه لكل الصفات المدروسه (طول النبات ، عدد الأفرع/نبات ، عدد القرون/نبات ، محصول بذور النبات الواحد ، محصول بذور القطعه التجريبيه ، محصول بذور الفدان كجم). أيضا أعطت النباتات التى رشت مرتين بمحلول فوسفات البوتاسيوم أعلى القيم لكل الصفات المدروسه ماعدا معامل الحصاد ونسبه البروتين فى كلا الموسمين.

-كان التفاعل بين الري والرش بفوسفات البوتاسيوم معنويا لكل الصفات المدروسه حيث أدى اعطاء ريتين (المحاياه والأخرى عند التزهير) مع التسميد الورقى مرتين فى الحصول على أطول النبات (٤٧,٣٤و ٤٥,٣٦سم) وأعلي عدد أفرع/نبات (٤,٥٢و ٤,٢٥) وأعلي عدد القرون/نبات (٤٦,٢٥و ٤٤,٣٥) وأعلي محصول بذور للنبات الواحد (١,٤٦و ١,٤٢جم) وأعلي معامل البذور (٢٦,٥٧ و ٢٧,٠٥ جم) وأعلي محصول بذور للقطعه التجريبيه (١,٧٨و ١,٧٦كجم) وأعلي محصول قش للقطعه التجريبيه (٦,٤٣ و ٦,٦٥ كجم) وأعلي محصول بذور/فدان (٧١٢و ٧٠٤ كجم) وذلك فى موسم النمو الاول والثانى على الترتيب.

-من نتائج هذه التجربه نجد انه يمكن الحصول على محصول عالى من محصول العدس برش النباتات مرتين بفوسفات البوتاسيوم مع اعطاء النباتات ريه عند التزهير بالأضافه لريه المحاياه تحت ظروف محافظة اسيوط.