IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 5 Ver. II (May. 2014), PP 07-11
www.iosrjournals.org

Effect of levels of phosphorus and iron on growth, yield and quality of flax

Akram Othman Esmail [1], Haifa Sediq Yasin [2], Bahar Jalal Mahmood [3]
[1]*(Soil and Water, Agriculture/ Salahaddin, Iraqi Kurdistan)*
[2]*(Soil and Water, Agriculture/ Salahaddin, Iraqi Kurdistan)*
[3]*(Field Crops, Agriculture/ Salahaddin, Iraqi Kurdistan)*

Abstract : *This study was conducted during the growing season of 2012-2013 from 1st December ,2012 to 26th of May, 2013 to study the effect of three levels of phosphorus(0, 50 and 100 kg TSP ha^{-1} and the three levels of Cheated iron (0, 4 and 8 kg Fe-EDDHA ha^{-1}) and their combinations on growth characters ,yield and quality of flax using split plot design with three replicates. The results indicated that the highest values of oil%, oil yield , P% , protein% and Fe concentration (23% , 346.47 kg .ha^{-1} ,6.65 %, 27.47 % and 151.90 ppm) were recorded from treatment combinations (P_0 Fe_1, P_1 Fe_0, P_2Fe_1, P_1Fe_0 and P_2Fe_2) respectively. On the other hand increase in levels of applied phosphorus and iron caused increase in seed index from (5.65 to 6.53 g) and from (5.24 to 6.39 g) respectively.*
Keywords: *Flax, Oil content, Chelated-Fe, Calcareous soil*

I. Introduction

Flax (*Linum usitatissumum L*) for seed production has emerged as an alternative crop species that allow increased diversification of cropping system in temperate environments (Khalifa et al., 2011).

Flax is grown all over the world for the oil extraction from the seeds and for its fibers, which are made into linen and other clothes. Various parts of the plant have been used to make fabric, dye, paper, medicines, fishing nets, hair gels and soap, it is also grown as an ornamental plants.

The seeds are widely used medically, which contains large amount of polyunsaturated fatty acids, alpha linoleic acid, which is an omega-3 fatty acid, linolenic acid which is an omega -6 fatty acid (Berti et al., 2009). Whole of crashed seeds are a reliable means of reliving constipation. The oil is also important in the manufacture of paints, soap and printers ink. (El-Nagdy et al., 2010).

It has a high percentage of essential fatty acid which plays a role in cell membrane synthesis by making them flexible, and affects several biological processes such as blood clotting and blood vessel contraction (El-Hariri et al., 1998).

The cultivated area of flax is decreasing yearly, due to great competition of other economic winter crops resulting a gap between production and consumption. Therefore it is necessary to increase flax productivity per unit area which could be achieved by using high yielding cultivars and improving the fertilization (Hussein, 2007) and improving the agricultural treatments (Nofal et al., 2011 and Grant et al., 2012).

One of these treatments is mineral fertilizers which are regarding as important factors for vigorous growth and consequently higher yield of different plant species (McKenzie and Allan, 2013).Nutritional disorders creating deficiency symptoms can be affected by un balanced fertilizer application, on the other hand the availability of P and micronutrients such as Fe, Mn, Zn and Cu are affecting by soil pH, soil CaCO3 content, soil organic matter and soil texture (Mengel and Frnest, 2010).

Phosphorus fertilization has great effect on crop production especially in calcareous soils. To optimize crop nutrition, P must be available to the crop in adequate amounts during the growing season (You et al., 2007).

Plants need P throughout their life cycle, especially during early growth stages for cell division and during maturity stage for seed formation and increase in seed weight. Placement of P in-row with cereal and oilseed crops has been the traditional method used for P fertilization in Alberta (Lafoand et al., 2003).

P is mobile in the plant, so it is absorbed during early growth and is later redirected for use in seed formation (Roy et al., 2007).

Higher P levels increased the yield and N use efficiency (Bakry et al., 2012).The medium to high soil P levels to optimize flax yields was recommended (Mousavi, 2011).

Iron is an essential micro element for plant growth; it plays an important role in the formation of chlorophyll A and chlorophyll B, carbohydrate production, cell respiration and chemical reduction of nitrate (Mousa et al., 2010). Iron is also necessary for the proper functioning of many plant enzyme systems that influence respiration and plant metabolism and helps oxidize sugar for energy (Ibrahim, 2009).

Micronutrients especially Fe and Zn are playing an important role in activity of enzymes or as functional, structural or regulatory cofactors (Cynthia et al., 2004).

Since the availability of phosphorus and iron is low in calcareous soil, due to high soil pH and high $CaCO_3$ content of the soil, this reduces the ability of nutrient uptake by plants (Hocking and Jand, 1993). For these reasons this study was selected to high light on the effect of levels of phosphorus and iron on growth characters, yield and quality of flax.

II. Material and methods

The field experiment was laid out at Grdarasha Agricultural farm, College of Agriculture, University of Salahaddin, Erbil, during growing season of (2012-2013), the aim of this investigation was to study the effect of P and Fe fertilizer on some growth characters, yield , yield component and some chemical properties of flax grown in calcareous soil, table (1) shows some chemical and physical properties of the soil(Esmail, 2012). The treatments were arranged in split-plot design with three replicates, the three levels of Triple super phosphate (TSP)were assigned in the main plots (0, 50 and,100 kg TSP ha^{-1} and the three levels of Cheated iron (0, 4 and 8 kg Fe-EDDHA ha^{-1}) were assigned in the sub-plot at sowing time.

Seeds were sowing on (1st December, 2012) and seeds were sown in rows 1.5 m length with 20 cm apart) and each experimental unit consisted of 5 rows. 100 kg Nitrogen ha^{-1} was applied in the form of urea 46% N to each plot before seeding. The experiment was done under rain feed condition with annual rainfall of 350 mm $year^{-1}$.The seeding rate was 55 kg ha^{-1} , at full maturity stage, ten plants were taken from each sub- plot (30 plants per treatment) to estimate or recording the following morphological and yield characters :

1-Plant height (cm). 2-Technical stem length (cm). 3- Fruiting zone length (cm). 4-Stem diameter (mm).
5- Number of fruiting branches /plant 6- Number of capsules per plant. 7- Number of seed per capsules.
8- Specific seed weight (seed index) or weight of 1000 seeds (g). 9- Biological yield kg ha^{-1}.
10 - Seed yield kg ha^{-1}. 11- Harvesting Index %.

Plants were harvested on 26th of May, 2013; capsules were removed carefully to determine straw yield and seed yield (kg ha^{-1}).Seed oil content was determined by soxhlet extraction apparatus using hexane according to the methods described by (A. O. A. C., 1975). The oil yield was calculated by multiplying seed yield ha-1 by seed oil percentage. Total Nitrogen was determined using Kjeldahl method then protein% was determined as follow:

Protein% =N % * 6.25.

P and Fe were determined using spectrophotometer and AAS respectively.

The data were statistically analyzed according to the technique of analysis of variance for Split plot design using SPSS program version 20 the difference among means of treatments were tested using Duncan's multiple range test at level of significant 5%.

Table (1) shows some chemical and physical of the soil of the field experiment.

PSD g kg^{-1}			Textural name		Water content (Kpa)				
Clay	Silt	Sand	Silty clay loam		S.P		F.C		W.P
350.7	521.3	128.0			50.52		26.81		14.98
Soluble ions mmolc.L^{-1}									
Ca^{2+}	Mg^{2+}	Na^{1+}	K^{1+}	HCO_3^{1-}	CO_3^{2-}	Cl^{1-}	SO_4^{2-}	pH	EC dS m^{-1}
2.63	0.72	0.43	0.20	2.32	0.0	0.54	1.32	7.51	0.42
OM g. kg^{-1}	$CaCO_3$ g kg^{-1}	Active $CaCO_3$ g kg^{-1}	Available phosphorus (mg kg^{-1} soil)						
10.1	24.31	4.52	2.47						

III. Results and discussion

Table (2) shows that the levels of phosphorus affected significantly on Harvesting index, stem diameter, and seed index only, the highest values of them(0.30, 2.11 mm and 6.53 g)were recorded from(P_1, P_2 and P_2 treatments respectively) this may be due to the role of applied P in root growth, nutrient uptake and seed formation (Mengel and Frnest, 2010) .

Table (2) Effect of levels of phosphorus on yield components.

	Biological yield Kg ha^{-1}	Seed yield Kg ha^{-1}	HI%	Stem length cm	Technical length cm	Fruit length cm	Diameter mm	Brunch No	Capsule No	Seed/ capsule	Seed index g
P_0	5306.93 a	1274.07a	0.24b	57.74 a	39.80 a	18.5 a	1.70 b	5.41 a	20.72 a	8.61 a	5.65 b
P_1	4310.28 a	1317.85a	0.30 a	55.12 a	39.49 a	15.63 a	1.90 ab	5.58 a	21.37 a	8.71 a	5.64 b
P_2	4202.34 a	1240.52a	0.29 a	60.24 a	41.89 a	18.24 a	2.11 a	5.89 a	23.11 a	8.42 a	6.53 a

Table (3) Explains that the levels of applied iron affected significantly on biological yield, Harvest index and seed index, the highest values of them (5994.07 kg ha^{-1}, 0.30 and 6.39 g) were recorded from treatments (Fe_1, Fe_0 and Fe_2) respectively this may be due to the role of iron in chlorophyll formation then increase in biological yield and seed index (Mengel and Frnest, 2010).

Table (3) Effect of levels of Iron on yield components on flax.

	Biological yield Kg ha^{-1}	Seed yield Kg ha^{-1}	HI%	Stem length cm	Technical length cm	Fruit length cm	Diameter mm	Brunch No	Capsule No	Seed/ capsule	Seed index g
Fe_0	3858.75b	1180.22a	0.30a	55.46^{a}	39.16^{a}	16.30^{a}	1.82^{a}	5.44^{a}	20.11^{a}	8.91^{a}	5.24^{b}
Fe_1	5994.07a	1476.85a	0.28ab	56.40^{a}	39.48^{a}	17.34^{a}	1.87^{a}	5.46^{a}	21.52^{a}	8.42^{a}	6.18^{a}
Fe_2	4666.73ab	1175.37a	0.26b	61.26^{a}	42.54^{a}	18.71^{a}	2.01^{a}	5.98^{a}	23.57^{a}	8.41^{a}	6.39^{a}

The statistical analysis indicated that the interaction treatments influenced significantly at level of significant 0.05 on biological yield ,harvest index and seed index only (table 4), the highest values (7031.07 kg.ha^{-1} , 0.31 % 7.09 g) were recorded from treatment combinations(P_0Fe_2, P_2Fe_0 and P_2Fe_1) respectively, while the lowest values 2986.20 kg.ha^{-1} ,0.21 and 4.58g were obtained from (P_0 Fe_0 , P_0 Fe_1 and P_1 Fe_0) this may be due to the single role of phosphorus as mentioned before or this may be due to the single effect of the studied factors or the interaction between P_2 and Fe_1 may created the best condition for plant growth.(Hocking and Jand, 1993 and Mengel and Frnest, 2010).

Table (4): Interaction effect of P and Fe on yield components and growth characters of flax.

	Biological yield Kg ha^{-1}	Seed yield Kg ha^{-1}	Hi %	Stem length cm	Technical length cm	Fruit length cm	Diameter mm	Brunch No	Capsule No	Seed/capsule	Seed index g
P_0 Fe_0	2986.20^{d}	905.33^{a}	0.30^{ab}	55.73^{a}	38.90^{a}	16.83^{a}	1.58^{a}	4.77^{a}	15.63^{a}	8.57^{a}	5.13^{bc}
P_0 Fe_1	5903.51^{ab}	1271.11^{a}	0.21^{c}	56.07^{a}	37.93^{a}	19.80^{a}	1.75^{a}	5.60^{a}	21.53^{a}	6.97^{a}	5.89^{ab}
P_0 Fe_2	7031.07^{a}	1645.78^{a}	0.23^{bc}	61.43^{a}	42.57^{a}	18.87^{a}	1.83^{a}	5.57^{a}	25.00^{a}	6.71^{a}	5.91^{ab}
P_1 Fe_0	5138.73^{abcd}	1549.55^{a}	0.29^{ab}	52.93^{a}	37.13^{a}	15.80^{a}	1.8^{a}	5.37^{a}	20.13^{a}	7.61^{a}	4.58^{c}
P_1 Fe_1	4563.31^{bcd}	1535.67^{a}	0.34^{a}	59.47^{a}	42.23^{a}	17.23^{a}	2.14^{a}	6.00^{a}	23.57^{a}	7.31^{a}	6.17^{ab}
P_1 Fe_2	3228.80^{cd}	868.33^{a}	0.26^{ab}c	57.70^{a}	41.43^{a}	16.27^{a}	2.14^{a}	6.20^{a}	24.57^{a}	6.97^{a}	6.00^{ab}
P_2 Fe_0	3451.31^{cd}	1085.77^{a}	0.31^{a}	60.17^{a}	41.40^{a}	18.43^{a}	2.11^{a}	5.40^{a}	22.63^{a}	7.07^{a}	6.50^{a}
P_2Fe_1	5415.38a^{bc}	1623.78^{a}	0.29^{ab}	62.87^{a}	42.83^{a}	20.03^{a}	2.07^{a}	6.07^{a}	22.13^{a}	7.64^{a}	7.09^{a}
P_2Fe_2	3740.33^{bcd}	1012.00^{a}	0.28^{abc}	52.97^{a}	39.10^{a}	13.87^{a}	1.76^{a}	5.37^{a}	20.40^{a}	7.64^{a}	6.16^{ab}

Table (5) refers to significant effect of phosphorus on oil content (%), oil yield (kg.ha^{-1}), phosphorus %, protein % Fe concentration (ppm) of flax , the highest value of them (21.92%, 288.87 kg.ha^{-1}, 6.00% and 24.31% and141.89 ppm) were recorded from P_1 treatment except the highest value of P% in flax (6.0%) and

Fe concentration (141.89 ppm) were recorded from P_2 treatment respectively , this explain that the application of phosphorus fertilizer to a certain level (P_1) caused a significant increase in most of the studied character ,this may be due to obtaining the best nutrient balance in plant in case of treatment (P_1) but at the highest level of P (treatment P_2) the concentration of (P) increased in plant then caused decrease in protein % of plant (table 5).

Table (5) Effect of levels of phosphorus on chemical characters of flax.

	Oil%	Oil yield	P%	protein	Fe ppm
P_0	20.47^b	260.80a	4.07^c	21.51^b	112.60^b
P_1	21.92^a	288.87^a	4.73^b	24.31^a	123.11^b
P_2	18.40^c	228.26^b	6.00^a	23.70^a	141.89^a

Table(6) indicated to significant effect of iron on oil% ,phosphorus content, protein% and Fe concentration (ppm) of flax ,the highest values of them(21.40%, 5.35%, 24.53% and 158.80) were recorded from treatments (Fe_0 , Fe_2 , Fe_0 and Fe_2) respectively .

Table (6) Effect of levels of Iron on some chemical properties of flax.

	Oil%	Oil yield	P%	protein%	Fe ppm
Fe_0	21.40^a	252.57a	4.90^b	24.53^a	112.60^b
Fe_1	20.15^b	297.58a	4.55^c	22.93^{ab}	146.89^a
Fe_2	19.23^c	226.02a	5.35^a	22.06^c	158.80^a

The highest oil and protein percentage may be due to the dilution effect since oil yield, seed yield & nitrogen content of seed with decrease in seed yield in Fe_2 then the highest protein contented was recorded from control treatments. The soil or foliar application of Fe, Cu and B significantly increased N and P uptake from soil and increased their content in flax plants (El-Nagdy et al., 2010 and You et al., 2007).

Table (7) shows the significant effect of interaction treatments at level of significant 5% on studied chemical properties ,the highest value of oil%, oil yield, P%, protein% and Fe concentration were recorded (23%, 346.47, 6.65, 27.47 and 151.90) from (P_0 Fe_1, P_1 Fe_0, P_2Fe_1, P_1Fe_0 and P_2Fe_2)respectively. This may be due to the single effect of the studied factors. Or the interaction between levels of phosphorus and iron created different growth conditions for plant growth which caused above results (A. O. A. C., 1975).

Table (7) Interaction effect of P and Fe on some chemical properties of flax.

	Oil%	Oil yield	P%	Protein%	Fe ppm
P_0 Fe_0	21.15^{bc}	190.68ab	4.15^{cd}	20.94^c	109.70^a
P_0 Fe_1	23.55^a	299.66 ab	3.55^d	26.50^{ab}	111.50^a
P_0 Fe_2	16.70^d	278.23 ab	4.50^{cd}	17.09^d	116.60^a
P_1 Fe_0	22.35^{ab}	346.47a	4.90^{bc}	27.47^a	113.11^a
P_1 Fe_1	23.45^a	308.55ab	4.90^{bc}	22.56^{bc}	119.00^a
P_1 Fe_2	20.70^c	303.65 ab	5.65^b	25.19^{ab}	137.22^b
P_2 Fe_0	16.95^d	224.60ab	5.70^b	19.38^{cd}	132.89^b
P_2Fe_1	17.55^d	275.29ab	6.65^a	26.53^{ab}	140.88^{bc}
P_2 Fe_2	19.95^c	177.53b	4.40^{cd}	22.91^{bc}	151.90^c

References

Journal Papers:

[1] Bakry, A.B:Elewa.T.A and Ali, A .M (2012).Effect of Fe foliar application on yield and quality traits of some flax varieties grown under newly reclaimed sandy soil. Australian J. of Basic and Applied Science. 6(7)532-536. ISSN1991-8178.

[2] Esmail, A.O.(2012) Effect of soil phosphorus equilibrium on P-availability for wheat using solubility diagram and DRIS-chart methods. Journal of University of Kirkuk for Agriculture Sciences Vol. (3), No.2.

[3] Berti, M.; Susana, F.; Rosemarie, W and Felicitas, H. (2009) .Flaxseed response to N, P, K fertilization in South Central Chile. Chilean Journal of Agricultural research 69(2):145-153.

[4] Cynthia,G.;M. Monreal: B. Irvine: D. McLaren and R. Mohr (2004). The role of phosphorus fertility and mycorrhyza in flax production. Agriculture and Agri-Food Canada, Brandon Research Center, Brandon, MB .cgrant@em.agr.ca (204) 726-7650.

[5] El-Nagdy, G. A.; Dalia,M.A.N.;Eman, A. E. and Gelan, S. A. EL (2010).Response of flax plant (*Linum usitatissumum* L) to treatments with mineral and Bio-fertilizers from Nitrogen and Phosphorus .Journal of American science :6(10).

[6] Esmail, A.O. (2012) Effect of soil phosphorus equilibrium on P-availability for wheat using solubility diagram and DRIS-chart methods. Journal of University of Kirkuk for Agriculture Sciences. Vol. (3), No.2.

[7] Grant .C.A, D.N. Flaten, D. J. Tomasiewicz,S.C.Sheppard and A.M.Johnston (2012) The importance of early season phosphorus nutrition. (cgrant@em.agr.ca).
[8] Hocking ,P. and Jand A. P.(1993). Phosphorus nutrition of linseed (*Linum usitatissimum* L.) as affected by nitrogen supply: effects on vegetative development and yield components. Field Crop Research, Vol. 32, Issues 1-2. (101-114).
[9] Hussein, M .M.M. (2007).Response of some flax genotypes to bio and nitrogen fertilization. Zagazig J. Agric. Res. 34 (5):815-844.
[10] Ibrahim, H.M (2009).Effect of sowing date and N- fertilizer levels on seed yield, some yield components and oil content in flax .J.Agri.Res. 54(1):19-28.
[11] Khalifa,R,Kh,M.;Manal,F.M.;Bakry,A.B. and Zeidan,M.S.(2011) Response of some flax varieties to micronutrients foliar application under newly reclaimed sandy soil. Australian Journal of Basic and Applied Science. 5(8):1328-1334.
[12] Mousa, M.A.; E.A.E. and Zedan, Z.S. (2010). Effect of nitrogen fertilizers and some micro nutrient on flax yield and chemical composition characters. Journal of Plant Production, Mansura University. 2090-3677.
[13] Mousavi, S.R. (2011).Zinc in crop production with phosphorus. Australian .J. of Basic and Applied Sciences: 5(9):1503-1509.
[14] Nofal, O.A:M.S. Zedian and B.A. Bakry (2011).Flax yield and quality traits as affected by Zn foliar application under newly reclaimed sandy soil .Journal of Applied Science Research, 7(9):1361-1367.
[15] You J. Cynthia, A, G. and Loraine, D, B (2007). Growth and nutrient response of flax and durum wheat to phosphorus and zinc fertilizers. Canadian Journal of Plant Science, 87(3): 461-470.

Books:

[16] A.O.A.C (1975) .Association of Official Analytical Chemists .Official methods of Analysis 12^{th} Ed.Washington .D.C. USA.
[17] El-Hariri,D.M.; M.S.Hassanein and M.A.Ahmed (1998) .Proceedings of the Hemp flax and other best fibrous plants ,production ,technology & ecology –symposium institute of natural fibers ,Poznan, Poland ,pp:20-26.
[18] Lafoand, G.P: C.A.Grant:A.M. Johnton: D.W.Mcandrew and W. E. May (2003). Nitrogen and phosphorus fertilizer management of No-till flax.
[19] McKenzie, R H and Allan, A. (2013). Phosphorus Fertilizer Application in Crop Production. Toll-free in Alberta at 310-farm 3276 for agriculture information.
[20] Mengel, K and Frnest, A.K (2010). Principles of Plant Nutrition. International Potash Institute. P.O. Box, CH-3048 Worblanfen-Bern/ Switzerland.
[21] Roy,R.N, A. Finck , G.J. Blair and H. L. S. Tandon (2007).Plant nutrition for food secretary . Discovery publishing house. New Delhi-110002.India.