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EFFECTS OF ZINC AND NITROGEN ON YIELD COMPONENTS OF FIVE FLAX GENOTYPES

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Abstract - Flax is one of the earliest plants that has been domesticated by humans. Due to high amounts of omega-3 fatty acid, its cultivation and consumption is increasing as a healthy oil resource. In nutritional point of physiology zinc and nitrogen are two important elements in plant biosynthesis. So in this experiment, effects of three levels of nitrogen (40, 60 and 80 kg/ha) and two levels of zinc sulfate (control and 3/1000) on five flax cultivars in split factorial based on randomized complete block design was investigated. The results showed that genotypes in terms of height, capsul number, seed yield and biological yield revealed significant differences ($P \leq 0.01$). In addition the results showed that the highest yield was obtained from treatment of 80 kg nitrogen and (3/1000) zinc sulfate spray.

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I. Introduction

Flax is an annual plant from Linacaea family. It is one of the most important medicinal plants due to its pharmaceutical active substances. It has different uses in pharmacy and cosmetics industries. So its cultivation is expanding all over the world. The origin of this plant was reported to be the west of Mediterranean region [10]. Flax is one of the oil seed plants and demand for its valuable oil and fatty acids, is increasing all over the world. The seed contain 40-45% oil and 23-34 % protein. Besides its valuable oil, seed meal with high percent of protein 42-46 percent, is also used in the animal diet [13]. Suitable fertilizing program is necessary for optimizing flax cultivation and its qualitative and quantitative characteristics [5]. Besides genotype and other environmental factors, plant nutrition and adequate levels of nutrient elements is prerequisite for maximum yield and quality. Surveys show that there is an increase of about 50% in food production due to use of chemical fertilizers [1]. Regarding plant production, effects of N fertilizers is higher than other fertilizers, however the efficiency of this fertilizers is low and frequently resulted in lodging and environmental pollution [19]. The amount of fertilizers that a crop needs depends to many factors including climate conditions, plant species and cultivar, and soil fertility levels [4]. However for micronutrients this can change a little bit, mainly due to their application method as in many cases they are used as foliar sparays [15]. Flax is a high sensitive plant to zinc deficiency [2] mostly resulted in pollen grains sterility, little leaf, chlorosis and dwarfing [8]. It was shown that foliar spray of zinc sulfate in canola increased seed yield, capsule number in plant, seed number in capsul, thousand weight, seed oil and protein [3,11]. Similarly it was shown that foliar application of zinc has significant increased seed yield, thousand weight and oil content, seed number in capsul, oil and seed yield in canola [16]. So according to incredible role of nutrient elements in quantity and quality of crops, this study was conducted to evaluate yield and quality response of five flax cultivars to different concentrations of nitrogen and zinc.

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II. Materials and Methods

This experiment was performed in thirty treatment and three replication in research farming of Shahid Bahonar University of Kerman, Iran. So different amounts of nitrogen and zinc on five flax cultivars was studied in factorial split design. The experiment region has a dry climate with hot and dry summers and cold winters. The experimental site has Loam and clay soil, and pH of 8.7. The first factor was nitrogen with three levels of (40- 60- 80 kg/ha) from urea source (40 kg as control) and second factor including zinc element with two level (0 and 3/1000) zinc sulfate and third factor including five flax cultivars, two native line with complete combination of brown seed color (Birjand and Courdestan) and three new line with yellow complete color (R_{11} ،R_4 and R_{24}). To provide phosphorous, 20 kg of phosphorous was added as strip application just 2.5 cm in side and 2.5 cm in below the seed. Nitrogen was divided in 3 applications, one before planting, one part after planting, another part before flowering in N treatments. Experimental plots were three lines with 2m length and a space of 40cm. Plants were irrigated every 7-10 days depending to plant requirement. Zinc sulfate was sprayed on leaves before flowering. During growing season different plant parameters were measured such as time of flowering, maturity, plant height, number of lateral shoots, number of capsule, number of seeds in capsule, weight of one thousand seed, seed yield for each genotype. Seed yield per plot as well as per plant was determined.

Data then were analyzed by SAS 9.1 statistical software, and comparison of means was performed by Duncan multiple comparison at 1% level.

III. Results and Discussion

Analysis of variance (Table1) revealed that flax cultivars in terms of height, number of capsule, seed yield and biologic yield showed significant differences (0.01%). Nitrogen levels (40, 60 and 80 kg/ha) in terms of height, capsule number, seed yield and biologic yield led to significant difference (0.01%). Zinc spray also in terms of height, capsule number, seed yield and biologic yield resulted in significant difference (1%) compared to control.

Table 1 : Analysis of variance for some physiological traits

SOV	Df	Plant height (cm)	No of branches	No of capsules	No of Seed in capsule	Biological yield(g)	Seed yield(gr)
Replication	2	5/3*	0/43ns	0/81ns	1/37ns	0/04ns	80/93ns
Nitrogen	2	47.71**	00.3ns	27.41**	1.11ns	0.51**	2013.6**
Zinc	1	30.62**	0.17ns	92.01**	2.5ns	0.42**	3973.3**
Nitrogenx Zinc	10	2.11ns	1.54ns	0.69ns	0.35ns	0.01ns	37.74ns
Genotype	4	6.96**	2.37ns	13.52**	1.65ns	0.15**	988.36**
nitrogenx genotype	8	8.06**	1.43ns	0.78ns	1.12ns	0.07*	285.74ns
Zinc xgenotype	4	4.31*	1.67ns	3.26ns	0.30ns	0.07ns	65.40ns
nitrogenx zincx genotype	8	8.34**	2.73*	5.93**	0.83ns	0.03ns	564.55**
Error	48	1.57	1.17	2.11	0.78	0.03	140.86
Total	89	425.71	126.40	424.05	72.98	5.55	29910
c.v	2.96	2.96	22.27	9.87	14.27	7.03	14.89

ns: not significant, * and ** significant at level of 5% and 1% respectively

Analysis of variance revealed that interaction effects of genotype and nitrogen in terms of plant height and biological yield, and also between genotype, nitrogen and zinc in terms of plant height, number of capsules and seed yield showed significant differences (1%). The highest plant height was in 80 kg/ha N, and lowest was in 40 kg/ha N treatment. The highest number of capsule was in 80 kg/ha N treatment, and the lowest capsule number was in 40 kg/ha N treatment. In terms of seed yield, 80 kg/ha led to higher amount compared to two other N levels. Availability of nitrogen is an important factor on distribution of photosynthetic assimilates between vegetative and reproductive organs. While increasing nitrogen consumption will enhance vegetative growth. This could be due to leaf expansion [21]. [6] reported that higher number of branches, number of capsule and seed yield obtained with nitrogen amount of 90 kg/ha.

Table 2 : Differences between N levels regarding some physiological traits

Zinc	Height (cm)	Branch number	Capsul number	Seed number in capsul	Biologic yield (gr)	Seed yield (gr)
(Z_0)	41.74b	4.91a	13.71b	6.04b	2.60b	73.02b
(Z_1)	42.90a	4.82a	15.7a	6.37a	2.74a	86.31a

Means with the same words in each column are not significantly different

Comparison of means (Table 3) shows that zinc application led to significant effect on plant height, capsule number, seed number in capsule, seed yield and biologic yield (P≤0.01). Zinc foliar application increase seed and biomass yield compared to control plants. Zinc is an important element in protein and oil biosynthesis in seeds [12]. In flax it also increases plant height, branches number, capsule number and seed yield [20]. It has been shown that spraying of zinc on flax led to higher growth rate and oil percentage [18]. Zinc with increasing lateral shoots, helps for more capsules. The results showed that both vegetative and flowering stages promoted by Zn spray, probable by increasing of photosynthesis rate and plant metabolism [14]. It has been shown also that application of zinc sulfate on canola leaves had significant role in seed yield improvement [11]. The role of zinc on improvement of yield component has been documented by other researches [16]. Application of zinc on some plants such as lentil [9], safflower [8], soybean [6] led to enhancement of seed yield components.

Table 3 : Difference of zinc levels for some physiological traits. z_0= control, z_1= 3/1000

Zinc	Height (cm)	Branch number	Capsul number	Seed number in capsul	Biologic yield (gr)	Seed yield (gr)
(Z_0)	41.74^b	4.91^a	13.71^b	6.04^b	2.60^b	73.02^b
(Z_1)	42.90^a	4.82^a	15.7^a	6.37^a	2.74^a	86.31^a

Means with the same words in each column are not significantly different

Table 4 : Comparison of cultivars regarding some growth factors

genotype	Height (cm)	Branch number	Capsul number	Seed number in capsul	Biologic yield (gr)	Seed yield (gr)
C1	41.40^b	5.27^a	15.83^a	6.38^a	2.81^a	90.88^a
C2	42.76^a	4.83^{ab}	15.05^{ab}	6.11^{ab}	2.65^b	78.61^b
C3	42.26^{ab}	4.38^b	14.72^b	6.38^a	2.67^b	79.55^b
C4	42.17^{ab}	4.66^{ab}	14.55^b	5.72^b	2.55^b	70.05^c
C5	43.02^a	5.16^{ab}	13.44^c	6.44^a	2.67^b	79.22^b

Means with the same words in each column are not significantly different

IV. Conclusion

Genotypes showed significant differences regarding growth factors, and R_{24} genotype showed significant higher amounts compared to other genotypes. So, it can be concluded that R_{24} genotype with 80 kg/ha N+ foliar spray of zinc is suitable for Kerman province in Iran.

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