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Evaluation Effect of Foliar Application of Methanol and Zinc Chelate on Crop Production of Cowpea (*Vigna Sinensis* L.) in Warm and Dry Climate Condition

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ABSTRACT

BACKGROUND: Addition of fertilizers to supplement the natural soil fertility is essential for modern crop production, and precise management of nutrient elements is essential for a sustainable agriculture production.

OBJECTIVES: The current research was conducted to assessment effect of different level of Methanol and Zinc fertilizer on seed yield and its components of Cowpea.

METHODS: This study was carried out according Factorial experiment based on randomized complete blocks design with three replications along 2018 year. The test factors consisted of different levels of Methanol in distilled water at three levels (a_1: the absence of methanol or control, a_2: 10% Vol., a_3: 20% Vol.) and zinc fertilizer (b_1: the lack of zinc or control, b_2: 2 per thousand, b_3: 4 per thousand).

RESULT: According result of analysis of variance effect of different level of Methanol and zinc fertilizer and interaction effect of treatments (number of pods per plant, number of seeds per pod, seed weight and harvest index) on all studied traits were significant. Among different level of Methanol the maximum amount of number of pods per m^2 (117.45), number of pods per plant (14.42), number of seeds per pod (11.4), seed weight (23.04 gr), seed yield (218.08 $gr.m^{-2}$), biologic yield (522.33 $gr.m^{-2}$) and harvest index (41.75%) was obtained for 20% Vol. Methanol and the minimum of mentioned traits were for control treatment. Assessment mean comparison result of different level of zinc fertilizer showed the highest amount of measured traits belonged to 4 per thousand concentration (also it doesn't have significant differences with 2 per thousand) and lowest ones was for control.

CONCLUSION: Finally according result of current research application 20%vol. Methanol and 2 per thousand concentrations Zinc Chelate had the highest amount of studied traits and it can be advice to producers in studied region.

KEYWORDS: *Fertilizer, Nutrition, Pulse, Seed, Yield.*

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1. BACKGROUND

Suitable and useful usage of different kind of fertilizers is the main way for reformation and potential of soil fertility and increasing of crops yield (Talaei, 2012). Grain legumes are a major source of protein in human and animal nutrition and play a key role in crop rotations in most parts of the world. When grown in rotation with other crops, under certain environmental conditions, they can improve soil fertility and reduce the incidence of weeds, diseases and pests (Albayrak *et al*., 2006). Foliar application of micro nutrients in semi-arid region can solve the immobilization of element in soil. However, actual movement of Nano-particles through the cuticle depends on the nutrient concentration, molecular size, chelating structure, time of application and plant species and environmental condition (Janmohamadi *et al*., 2016). Zinc is the second most abundant transition metal after iron and is involved in various biological processes in organisms (Sida-Arreola *et al*., 2017). Zinc (Zn) is an important transitional metal, and is the only metal present in all six classes of enzymes and act as component for several transcriptional factors (Prasad *et al*., 2012). Zn plays an important role in the synthesis of proteins and carbohydrates (Sajedi, *et al*., 2009). Zinc plays a significant role in various enzymatic and physiological activities in the plant system. It performs many catalytic function in the plant besides transformation of carbohydrates, chlorophyll and protein synthesis. Under conditions where there is a lack of zinc, a decrease of carbonic anhydrase enzyme can lead to a diminished rate of net photosynthesis. The use of zinc serves to increase the density of zinc and protein in seeds, pneumatic organs and the overall quality of seed production (Sharma *et al.*, 2014). Zinc is a necessary component of various enzyme systems for energy production, protein synthesis, energy production, maintains the structural integrity of bio membranes and growth regulation (Hansch and Mendel, 2009). Zinc deficiencies are mainly found on sandy soils low in organic matter and on alkaline soils. Uptake of zinc also is adversely affected by high pH, high levels of available phosphorus and iron in soils (Ghasemi-Fasaei and Ronaghi, 2008). Jokar *et al*. (2015) by evaluate the effects of different levels of iron (0, 0.135, 0.270 and 0.405 mg Fe per kg soil as Fe-Nano-chelate or Fe-EDDHA) on growth parameters, concentration and absorption of Fe and some nutrients in cowpea reported application of both Fe-Nano-chelate and Fe-EDDHA decreased phosphorus and manganese concentrations in shoots as compared to control treatment. Salehin and Rahman (2012) by evaluated effects of zinc, nitrogen fertilizer and their application method on yield and its components of *Ph. vulgaris* L. reported the highest seed yield (1996 $kg.ha^{-1}$) was obtained by zinc spray application in amount 1 $g.L^{-1}$, also use of 90 $kg.ha^{-1}$ pure nitrogen produced highest seed yield.

2. OBJECTIVES

The current research was conducted to assessment effect of different level of Methanol and Zinc fertilizer on seed yield and its components of Cowpea.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current research was carried out to response of crop production of Cow Pea to apply different level of Methanol and Zinc fertilizer via Factorial experiment based on randomized complete blocks design with three replications along 2018 year. Place of research was located in Ahvaz City at longitude 48°40'E and latitude 31°20'N in Khuzestan province (Southwest of Iran). The test factors consisted of different levels of Methanol in distilled water at three levels (a_1: the absence of methanol or control, a_2: 10% Vol., a_3: 20% Vol.) and zinc fertilizer in three levels (b_1: the lack of zinc or control, b_2: 2 per thousand, b_3: 4 per thousand).

3.2. Farm Management

Base fertilizers (50 $kg.ha^{-1}$ Nitrogen from urea, 80 $kg.ha^{-1}$ phosphorus from ammonium phosphate and 80 $kg.ha^{-1}$ potassium from potassium sulfate) were added to the soil based on soil tests and the recommendations of the Iranian Soil and Water Research Institute at the planting stage. The light-disk harrow was used to mix soil and the fertilizer after soil fertilization. The furrower was used to make furrows at a distance of 50 cm. The zinc and manganese Nano-chelate were used in the furrows (with 4cm depth) before planting. The furrows were covered with soil. The seeds were planted 2 cm above the fertilizer. Physical and chemical properties of the soil are mentioned in table 1.

Table 1. Physical and chemical properties of studied field

Depth of soil (cm)	P (ppm)	K (ppm)	N (%)	pH	EC ($ds.m^{-1}$)	OC (%)	Soil texture
0-15	5	224	5.3	7.2	4	0.64	Clayloam
15-30	4.41	219	5.1	7	3.94	0.57	Clayloam

3.3. Measured Traits

After physiological ripening seed yield, biologic yield, number of pods per m^2, number of pods per plant, number seeds per pod and seed weight was determined. Harvest index (HI) was calculated according to formula of Gardener *et al*. (1985) as follows: **Equ.1.** HI= (Seed yield/Biologic yield) ×100.

3.4. Statistical Analysis

Analysis of variance and mean comparisons were done via SAS (Ver.8) software and Duncan multiple range test at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Number of pods per square meter

Result of analysis of variance revealed effect of Methanol, Zinc Chelate and interaction effect of treatments on number of pods per square meter was significant at 1% probability level (Table 2). Mean comparison result of different level of Methanol indicated that maximum number of pods per square meter (117.45) was noted for 20%vol. and minimum of that (94.84) belonged to control treatment (Table 3). As for Duncan classification made with respect to different level of Zinc Chelate maximum and minimum amount of number

of pods per square meter belonged to 4 per thousand concentration also it doesn't have significant differences with 2 per thousand (114.3) and control (92.57) (Table 4). Evaluation mean comparison result of interaction effect of treatments indicated maximum number of pods per square meter (125.26) was noted for 20%vol. Methanol and 4 per thousand concentration Zinc Chelate (also it doesn't have significant differences with 2 per thousand) and lowest one (89) belonged to control treatment (Table 5). Tabatabian (2009) obtained the highest seed weight of wheat by application of 2.5 $mg.kg^{-1}$ zinc sulphate. According his opinion, the presence of sufficient nutrients in plant organs will improve seed filling and increase seed weight. Zinc is an element involved in the building up of enzymes in plants and can play an important role in the synthesis of proteins and carbohydrates (Hemantaranjan, 2013).

Table 2. Result analysis of variance of measured traits

S.O.V	df	Number of pods per m^2	Number of pods per plant	Number of seeds per pod	Seed weight
Replication	2	50.4^{ns}	3.75^{ns}	5.34^{ns}	12.07^{ns}
Methanol (M)	2	1851**	184.02**	7.88*	83.22**
Zinc Chelate (Z)	2	1413**	251.61**	6.53*	91.81**
M × Z	4	1050.1**	1.43^{ns}	0.12^{ns}	3.45^{ns}
Error	16	90.25	3.04	0.63	1.75
CV (%)	-	8.98	14.17	8.40	13.22

ns, * and ** are non-significant and significant at 5 and 1% probability levels, respectively.

Continue table 2.

S.O.V	df	Seed yield	Biologic yield	Harvest index
Replication	2	188.3^{ns}	31.75^{ns}	0.07^{ns}
Methanol (M)	2	30742.3**	53800.05**	94.67*
Zinc Chelate (Z)	2	26852.1**	46573.2**	75.31*
M × Z	4	10574.33**	19619.04**	3.38^{ns}
Error	16	398.56	1180.37	11.04
CV (%)	-	10.51	7.17	8.4

ns, * and ** are non-significant and significant at 5 and 1% probability levels, respectively.

4.2. Number of pods per plant

According result of analysis of variance effect of Methanol and Zinc Chelate on number of pods per plant was significant at 1% probability level but interaction effect of treatments was not significant (Table 2). According result of mean comparison maximum of num-

ber of pods per plant (14.42) was obtained for 20%vol. Methanol and minimum of that (10.22) was for control treatment (Table 3). Evaluation mean comparison result indicated in different level of Zinc Chelate the maximum number of pods per plant (13.53) was noted for 4 per thousand concentrations and minimum of that (11) belonged to control treatment (Table 4). Tabatabaeian (2012) reported zinc sulfate application had a positive and significant effect on the most studied traits, so that application of 2.5 $mg.kg^{-1}$ zinc sulfate at complete irrigation treatment increased grain yield up to 27%. Besides, zinc concentration of seeds increased as zinc sulfate was applied.

Table 3. Mean comparison effect of different levels of Methanol on measured traits

Treatment	Number of pods per m^2	Number of pods per plant	Number of seeds per pod	Seed weight (gr)
Nonuse of Methanol or control	94.84c	10.22c	7.09c	18.65c
10% Vol.	104.82b	12.27b	9.84b	21.01b
20% Vol.	117.45a	14.42a	11.4a	23.04a

*Similar letters in each column show non-significant difference at 5% probability level in Duncan test.

Continue table 3.

Treatment	Seed yield ($gr.m^{-2}$)	Biologic yield ($gr.m^{-2}$)	Harvest index (%)
Nonuse of Methanol or control	167.24c	465.13c	35.95b
10% Vol.	184.1b	499b	36.89ab
20% Vol.	218.08a	522.33a	41.75a

*Similar letters in each column show non-significant difference at 5% probability level in Duncan test.

4.3. Number of seeds per pod

Result of analysis of variance showed effect of Methanol and Zinc Chelate on number of seeds per pod was significant at 5% probability level but interaction effect of treatments was not significant (Table 2). Assessment mean comparison result indicated in different level of Methanol the maximum number of seeds per pod (11.4) was noted for 20%vol. and minimum of that (7.09) belonged to control treatment (Table 3). Compare different level of Zinc Chelate showed that the maximum and the minimum amount of number of seeds per pod belonged to 4 per thousand concentrations (10.9) (also it doesn't have significant differences with 2 per thousand) and control (7.87) treatments (Table 4). Thandon (2012) reported an increase in wheat yield due to zinc intake in compare to control was 860 $kg.ha^{-1}$. Mohseni *et al*. (2006) reported that zinc sulfate consumption had a significant effect on seed yield and improve crop production which was in agreement with the results of this study.

4.4. Seed weight

According result of analysis of variance effect of Methanol and Zinc Chelate on seed weight was significant at 1% probability level but interaction effect of treatments was not significant (Table 2). Evaluation mean comparison result revealed in different level of Methanol the maximum seed weight (23.04 gr) was noted for 20%vol. and minimum of that (18.65 gr) belonged to control treatment (Table 3). Manojlovis (2012) reported that the use of zinc can increase corn yield by up to 50%. Between different levels of Zinc Chelate the maximum seed weight (22.78 gr) was observed 4 per thousand concentrations (also it doesn't have significant differences with 2 per thousand) and control (18.94 gr) treatments (Table 4).

Table 4. Mean comparison effect of different levels of Zinc on measured traits

Treatment	Number of pods per m^2	Number of pods per plant	Number of seeds per pod	Seed weight (gr)
Nonuse of Zinc or control	92.57b	11b	7.87b	18.94b
2 per thousand	110.23a	12.37ab	9.56a	21a
4 per thousand	114.3a	13.53a	10.9a	22.78a

*Similar letters in each column show non-significant difference at 5% probability level in Duncan test.

Continue table 4.

Treatment	Seed yield ($gr.m^{-2}$)	Biologic yield ($gr.m^{-2}$)	Harvest index (%)
Nonuse of Zinc or control	170.3b	442.33b	38.5b
2 per thousand	195.51a	494.16a	39.56ab
4 per thousand	203.61a	500.2a	40.7a

*Similar letters in each column show non-significant difference at 5% probability level in Duncan test.

4.5. Seed yield

Result of analysis of variance revealed effect of Methanol, Zinc Chelate and interaction effect of treatments on seed yield was significant at 1% probability level (Table 2). Mean comparison result of different level of Methanol indicated the maximum and the minimum amount of seed yield belonged to 20%vol. (218.08 $gr.m^{-2}$) and control treatment (167.24 $gr.m^{-2}$) (Table 3). Soleymani and Shahrajabian (2016) reported that application of zinc fertilizer treatment led to the highest biological yield and seed yield due to the positive effect of zinc on biosynthesis of auxin and positive effect of iron on photosynthesis and improved plant growth. Among different level of Zinc Chelate maximum seed yield (203.61 $gr.m^{-2}$) was obtained for 4 per thousand concentrations (also it doesn't have significant differences with 2 per thousand) and control (170.3 $gr.m^{-2}$) treatments (Table 4). Shojaei and Makariyan (2015) by evaluate the effect of three levels of zinc fertilizers (control, 5, 10 g per liter of zinc oxide) on yield and its

components of Mungbean reported that zinc fertilizer significantly increased the number of pods per plant. Evaluation mean comparison result of interaction effect of treatments indicated maximum seed yield (235.76 gr.m^{-2}) was noted for 20%vol. Methanol and 4 per thousand concentration Zinc Chelate (also it doesn't have significant differences with 2 per thousand) and lowest one (149.5 gr.m^{-2}) belonged to control treatment (Table 5).

Table 5. Mean comparison interaction effect of treatment on measured traits

Methanol	Zinc Chelate	Number of pods per m^2	Seed yield (gr.m^{-2})	Biologic yield (gr.m^{-2})
Nonuse of Methanol or control	**Nonuse of Zinc or control**	89d	149.5d	421.25e
	2 per thousand	97.1c	178.3c	429.06d
	4 per thousand	100c	180.69c	432d
10% Vol.	**Nonuse of Zinc or control**	92.6cd	171.9d	482c
	2 per thousand	107bc	186.5b	499.01b
	4 per thousand	111.46b	190.73b	500b
20% Vol.	**Nonuse of Zinc or control**	106.3bc	183.43bc	488.33c
	2 per thousand	123a	231.73a	527.5a
	4 per thousand	125.26a	235.76a	530.53a

*Similar letters in each column show non-significant difference at 5% probability level in Duncan test.

4.6. Biologic yield

According result of analysis of variance effect of Methanol, Zinc Chelate and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 2). Assessment mean comparison result indicated in different level of Methanol the maximum biologic yield (522.33 gr.m^{-2}) was noted for 20%vol. and minimum of that (465.13 gr.m^{-2}) belonged to control treatment (Table 3). Compare different level of Zinc Chelate showed that the maximum and the minimum amount of biologic yield belonged to 4 per thousand concentrations (500.2 gr.m^{-2}) (also it doesn't have significant differences with 2 per thousand) and control (442.33 gr.m^{-2}) treatments (Table 4). Saeedin (2016) evaluated the correlation between biological yield and seed yield of cowpea and reported a positive and significant correlation between mentioned traits. Its seem biological yield increased because of accumulation of photosynthetic products (source products) and high potential of seeds (reservoir) for absorption and accumulation of dry matter. Therefore, any increases in seed yield also increases the biological yield. However, less dry matter is accumulated in case of micronutrient deficiency, which decreases the biological yield. Evaluation mean comparison result of interaction effect of treatments indicated maximum biologic yield (530.53 gr.m^{-2}) was noted for 20%vol. Methanol and 4 per thousand concentration Zinc Chelate (also it doesn't have significant differences with 2 per thousand) and lowest one (421.25 gr.m^{-2}) belonged to control treatment (Table 5).

4.7. Harvest index

Result of analysis of variance showed effect of Methanol and Zinc Chelate on harvest index was significant at 5% probability level but interaction effect of treatments was not significant (Table 2). Mean comparison result of different level of Methanol indicated that maximum harvest index (41.75%) was noted for 20%vol. and minimum of that (35.95%) belonged to control treatment (Table 3). As for Duncan classification made with respect to different level of Zinc Chelate maximum and minimum amount of harvest index belonged to 4 per thousand concentration also it doesn't have significant differences with 2 per thousand (40.7%) and control (38.5%) (Table 4).

5. CONCLUSION

Finally according result of current research application 20%vol. Methanol and 2 per thousand concentration Zinc Chelate had the highest amount of studied traits and it can be advice to producers in studied region.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

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