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EFFECT OF SEED PRIMING WITH MANGANESE AND BORON ON GROWTH, YIELD AND SEED QUALITY OF CHICKPEA (*Cicer arietinum* L.)

Bilal I. Mohammed
Department of Plant Production, Khabat Technical Institute, Erbil Polytechnic University, Kurdistan Region, Iraq

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Correspondence Email:
bilal.muhammed@epu.edu.iq

ABSTRACT

This study was conducted at two locations; the field of Khabat Technical Institute-Erbil Polytechnic University and field of agriculture directory in Harir-Erbil, during spring 2021. To study the effect of seed priming with manganese and boron on growth, yield and quality of chickpea. A randomized complete block design (RCBD) with three replications was used, the first factor represented priming of seeds by four concentrations of manganese: (0, 2, 4 and 6 g liter-1) and second factor boron (0, 2, 4 and 6 g liter-1). Seed priming by 4 g liter-1 of manganese and 4 g liter-1 of boron from Harir location produced the heights of plant height (cm), leaf area (cm2), leaf area index, dry matter (g m2), number of pod plant-1, number of seeds pod-1, weight of 100 seeds (g), seed yield (kg ha-1) and protein yield (kg ha-1). The heights percentage of protein%, oil% and nitrogen% was recorded at 2 g liter-1 of Mn and B, while carbohydrate%, phosphorus% and potassium% recorded at 4 g liter-1 of Mn and 2 g liter-1 of B from both locations. From interaction between manganese and boron concentrations was from Harir location at 4 g liter-1 of Mn with 4 g liter-1 of B for all growth parameters, yield and yield components, but the heights percentage of protein%, oil% and nitrogen%, was recorded from interaction Mn with B at 2 g liter-1, while carbohydrate%, phosphorus% and potassium% was recorded at 4 g liter-1 Mn with 2 g liter-1 B from both locations.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) belong to the family Fabaceae, an annual and one of important pulse crop. Chickpea is an important source of protein for millions of people in the developing countries. In addition, it is a very good source of proteins having high protein content (20-22%) and rich in carbohydrates, fiber, high amount of minerals and low in fat content and most of it is polyunsaturated (Wallace et al., 2016). Chickpea is grown in more than 50 countries and the world production is about (15,083,871.00) tones, including India which produce about 75% of the world production, however, the production of chickpeas in Iraq is up to (1,300) tons, according to (FAO, 2020). It is mainly cultivated on non-irrigated soils, and water stress often affects both productivity and yield stability (Kurdali, 1996). Non-irrigated soils are generally impoverished, with low native fertility. Although chickpea is a rustic plant, a limited moisture supply together with mineral nutrient deficiencies and imbalances in the soil are considered major environmental stresses leading to yield loss in chickpea (Khan, 1998). Plant nutrient availability depends, among other factors, on texture, on organic matter content and especially on soil pH. Micronutrient deficiencies can restrict nitrogen fixation by the legume-rhizobium symbiosis, which limits nitrogen fixation by legumes, and their influence on the efficient uptake of the principal and secondary nutrients all contribute significantly to achieving higher production. (Valenciano et al., 2011).

Seed priming it is a technique that improves the germination and growth of seeds, even if under different conditions, and this soaking process is done by leaving the seeds to be soaked solution for a specific period, then the process of drying the seeds and then replanted after that (McDonald, 2005). Seed priming is the process of revitalizing seeds before planting by soaking them in different solutions, is one technique used to boost the rate of seedling vigor (Ashraf and Foolad, 2005). Seed treatment is a better option from an economical perspective as less micronutrient is needed, it is easy to apply and seedling growth is improved (Singh et al., 2005). Micronutrients play an essential role in increasing the yield of pulse and oilseed through their effects on the plant and also on the nitrogen-fixing process (Gaur et al., 2010). Micronutrients can use as material for seed priming, Nano priming of micronutrients is a new method for the rise of seedling vigor and development of germination percentage (Valadkhan et al., 2015).

Manganese plays an important role in nitrogen metabolism and photosynthesis and forms several other compounds that demand plant metabolism (Stout and Arnon, 1939). Treatments with dilute concentrations of manganese gave a significant increase over control; the highest yield was obtained from seed soaking treatments in 1.5% Mn and 1.5% Mn solutions (Mirshekari, 2010; Mirshekari et al., 2012). Boron is a micronutrient plays an important role in increasing yield of pulse legumes. It is very important in cell division and in pod and seed formation (Alam et al., 2017). The application of boron resulted in a higher production of dry matter, due to an increase of the dry weight of pods including seeds (Valenciano et al., 2010). Seed yield of chickpea increased with the soil application of B at 2.5 kg ha-1 (Pal et al., 2021). Boron deficiency limits chickpea productivity, it has been shown to have a significant limiting effect on chickpea yield in some regions with acid soil conditions (Ahlawat et al., 2007). Most of Khabat and Harir in Erbil government soils are deficient in these nutrients, and must be supplemented through proper crop nutrients manage-meant, using enriched seeds by micronutrient priming are found to be as a better strategy for overcoming micronutrient deficiencies. The aim of this research is effect of chickpea seed priming with manganese and boron solution at different concentration on growth parameters, yield and seed quality from both locations Khabat and Harir.

MATERIALS AND METHODS

This study was conducted at two locations; the field of Khabat Technical Institute-Erbil Polytechnic University, Latitude 36° 4' N and Longitude 44°2' E, with the elevation of 415 meter above sea level and the field belonging to agriculture directory of Harir-Erbil, Latitude 36° 55' N and Longitude 44°35' E, with the elevation of 700 meter above sea level, during the spring growing season 2021. The Factorial experiment was applied in a randomized complete block design (RCBD), with three replications. A seed of chickpea genotype (Hazar-merd) was cultivated, the first factor represented soaking of seed by four concentrations of manganese: (0, 2, 4 and 6 g liter-1) and the second factor boron concentrations (0, 2, 4 and 6 g liter-1). Typical samples were taken from both locations of the field at depths (0-30 cm) after plowing. These samples were air dried and then sieved using a 2 mm sieve size, and then packed for some physical and chemical parameters analysis Table (1).

The field was plowed for preparing a good seedbed and also to controlling weeds prior of planting, the land was divided manually to plots, and each Block contained 16 experimental units (2 m×2 m). Nitrogen fertilizer at rate of 100 kg N ha-1 in the form of urea (46%N), and P2O5 at a rate of 80 kg ha-1 in the form of triple super phosphate (46% P2O5) were applied at time of sowing. The variety of chickpea genotype (Hazar-merd) was taken at the Agricultural Research Station Center in Sulaymaniyah. The seeds were priming by soaking for 12 hours before planting in different solutions according to manganese sulphate (MnSO4) and boric acid (H3BO3) concentrations (g liter-1), and studying the extent of their effect on seed activation and its reflection on the characteristics of growth, yield and seed quality of chickpea. Planted manually from both locations in (15-February-2021) at row spacing of 30 cm and 10 cm between plants in each row. Two seeds were planted in each hill at a depth of 3 cm, and then seedlings were thinned to (30 plant m-1). Ten plants from each experimental unit randomly were taken at flowering stage to determine some growth parameters; plant height cm, leaf area (cm2) and leaf area index (LAI) from viticanopy program application, dry matter (gm-2); which represents the dry mass of total green parts of plant after drying at 80°C for (48) hours, then weight was converted to gm-2. Crop growth rate (CGR) g m-2 day-1; It was calculated by dividing dry matter yield (gm-2) at flowering stage by number of days from sowing to the flowering stage (Hunt, 1990).

Table (1): Physical and chemical parameters of both soils at the depth of (0-30 cm).

Depth 0-30 cm	PSD %			Soil Texture	pH	Ec ds/m	O.M %	(N) %	Available (P)	K^+	Ca^{+2}	Mg^{+2}	Mn	B
	Sand	Silt	Clay											
	g/kg soil					dS/m	%		mg g^{-1}	Mmolic L^{-1}			ppm	
Khabat	6	50	44	Silty clay	7.5	1.3	1.1	0.27	3.76	0.22	6.57	3.98	25.6	21.6
Harir	13	21.5	65.5	Clay loam	7.8	0.80	1.03	0.23	1.86	0.83	7.67	6.21	23.5	20.4

From middle lines, to study yield and yield components; number of primary branches plant-1, number of pod plant-1, number of seeds pod-1, weight of 100 seeds (g), seed yield (kg ha-1) and protein yield (kg ha-1). The study of seed quality from seeds taken after harvesting; protein percentage%, oil percentage%, carbohydrate percentage%, nitrogen% (N), phosphorus% (P2O5) and potassium% (K2O). The data was analyzed statistically for all of the studied traits (Gupta et al., 2016), according to analyses of variance using the Statistical Analysis System (SAS Institute, 2004). Duncan's multiple range test DMRT at 5% level of significance was used to the compare among means (Steel and Torrie, 1997). The metrological data for both locations are taken for (Khabat and Harir) field stations during spring season of (2021), from Erbil government Table (2).

Table (2): Metrological data for Khabat and Harir field stations during spring season of (2021).

Parameter Years 2021		Air Temperature in (°C)			Monthly total rainfalls mm	Relative Humidity R.H%
Location		Maximum	Minimum	Average		
Khabat	February	19.5	5.2	12.4	24.0	74.4
	March	22.0	5.8	13.9	16.1	73.9
	April	30.2	12.0	21.1	2.3	58.4
	May	38.3	17.0	27.7	0.1	47.3
	Jun	41.3	21.7	31.5	0	42.8
Harir	February	15.4	8.3	10.2	86.6	70.1
	March	20.4	5.1	12.8	34.5	65.3
	April	24.8	14.2	19.6	50.3	50.8
	May	28.8	19.0	23.6	2.2	47.0
	Jun	36.9	23.7	30.3	0	41.4

RESULTS & DISCUSSION:

Effect of seed priming on some growth parameters of chickpea:

Plant height (cm):

The data presented confirms the significant difference between seed priming and the plant height, (44.91) cm was recorded at 4 g liter^{-1} of manganese in Harir location, compared with planting in Khabat location at control; 0 g liter^{-1} Mn which recorded the lowest (32.16) cm Table (3), Boron concentration effected significantly for both location, the heights plant height (41.66) cm was recorded at 4 g liter^{-1} of Boron in Harir location, and the lowest (35.91) cm which recorded in Khabat location at control; 0 g liter^{-1} B Table (3). Seed priming with Mn and B caused heights plant height compared with control, because this micronutrient results plays a vital role in cell division, distinction and generative growth of plants. Hoque et al., (2021). However, the interaction among manganese and boron was also shows significant differences, the heights plant height (50.00) cm was obtained for 4 g liter^{-1} of Mn with 4 g liter^{-1} of B in Harir location, while the lowest (30.33) was recorded from Khabat location at 0 g liter^{-1} of Mn with 0 g liter^{-1} of B.

Leaf area (cm^2):

The data in Table (3) shows influenced by manganese, boron and their interactions between them for both locations, 4 g liter^{-1} of Mn showed significantly higher leaf area (795.25 cm^2) in Harir location as compared to 0 g liter^{-1} of Mn in Khabat location. Boron recorded significantly higher leaf area (720.33 cm^2) in Harir location compared with 0 g liter^{-1} of B was recorded lowest (570.83 cm^2) in Khabat location. Seed priming with micronutrient might be evident that seed treatment with micronutrients might have the potential to meet crop micronutrient requirements and improve growth parameters and yield Rahman et al., (2014). The highest leaf area

(880.00 cm^2) at 4 g $liter^{-1}$ of Mn with 4 g $liter^{-1}$ of B when planted in Harir location, compared with 0 g $liter^{-1}$ of Mn when planted at 0 g $liter^{-1}$ of B in Khabat location recorded lowest (422.33 cm^2). The increase in the leafy area in the Harir location is due to a difference in the environment and the increase in the duration of plant survival in the field due to the delay in rising temperatures compared to the Khabat location.

Leaf area index (LAI):

The results shown in Table (3), the heights of leaf area index were recorded at 4 g $liter^{-1}$ of Mn (2.65) in Harir location but the lowest has shown Khabat location at 0 g $liter^{-1}$ of Mn (1.73). Boron concentration has significantly recorded higher leaf area index at 4 g $liter^{-1}$ in Harir location compared with 0 g $liter^{-1}$ B was recorded lowest in Khabat location. Planting chickpea by seed priming at 4 g $liter^{-1}$ of Mn with 4 g $liter^{-1}$ of B recorded the heights of leaf area index was (2.93) in Harir location, compared with planting at 0 g $liter^{-1}$ of Mn with 0 g $liter^{-1}$ of B in Khabat location (1.40). Martin (1983) found that delay in planting of sugar beet crop from November to March gradually decreased leaf area index.

Dry matter (g m^2):

The results in Table (3) showed significant differences among all the studied factors, dry matter (43.48 g m^2), was produced higher at 4 g $liter^{-1}$ of Mn in Harir location, and the heights value of dry matter (42.65 g m^2) recorded when applied seed priming by 4 g $liter^{-1}$ of B in the same location, compared with same concentration of Mn and B in Khabat location there were highly significant differences between environments for dry matter production. This indicates the strong influence of the environment on chickpea performance. From interaction between seed priming by manganese and boron resulted the heights value of dry matter (48.22 g m^2) at 4 g $liter^{-1}$ of Mn with 4 g $liter^{-1}$ of B in Harir location as compared with planting on Khabat location at 0 g $liter^{-1}$ of Mn with 0 g $liter^{-1}$ of B (25.11 g m^2). The dry matter accumulation increase, with increased boron supply, was mostly due to the increase in the number of pods (including seeds) $plant^{-1}$ Pal et al., (2021).

Crop growth rate (g m^2 day^{-1}):

The results of analysis of variance in Table (3) showed significant differences among all studied factors and their interaction. The cultivated plants by seed priming at 4 g $liter^{-1}$ of Mn gave the highest rate of crop growth reached (7.24 g m^{-2} day^{-1}), and boron concentration the highest rate (6.56 g m^{-2} day^{-1}) obtained at 4 g $liter^{-1}$ of B in Harir location. The increase of (CGR) in 4 g $liter^{-1}$ of Mn and B caused in increase leave area and dry matter in same concentrations from Harir location. The highest rate of crop growth from interaction 4 g $liter^{-1}$ of Mn with 4 g $liter^{-1}$ of B (8.03 g m^{-2} day^{-1}) in Harir location, while 0 g $liter^{-1}$ of Mn with 0 g $liter^{-1}$ of B produced the lowest value for this trait (4.18 g m^{-2} day^{-1}) when planted in Khabat location.

Effect of seed priming on yield and yield components of chickpea:
Number of primary branches $plant^{-1}$:

Table (4) shows the effect of seed priming by manganese, boron and their interaction for components analysis of chickpea. The maximum no. of primary branch registers in 4 g liter-1 of Mn and 4 g liter-1 of B (3.84 and 3.81) respectively in Khabat location, whereas the minimum was for 0 g liter-1 of Mn and 0 g liter-1 of B which was (2.86 and 2.93) respectively, from the same location. These results are agreed with those of Alam et al., (2017) whom reported that seed priming with boron observed highest number of primary branches plant-1 at 3 kg B ha-1 and the lowest was observed at control treatment (0 kg B ha-1). However, the interaction between manganese with boron obtained significantly higher number of primary branches in 4 g liter-1 of Mn with 4 g liter-1 of B (4.50) in Khabat location, but the lower value was recorded for 6 g liter-1 of Mn with 6 g liter-1 of B (2.10) in the same location.

Number of pod plant-1:

The results of number of pods plant-1 are displayed in Table (4). A wide variation was observed in these results, the highest number of pods plant−1 was at 4 g liter-1 of Mn (26.00) and 4 g liter-1 of B (24.44) in Harir location, while the lowest number was recorded at 0 g liter-1 of Mn which was (20.25) in Khabat location, and (20.50) at 0 g liter-1 of B from the Harir location. This result is agreed with Rahman et al., (2014) which reported that seed priming by micronutrient as boron increase number of pod plant-1 at 4 g kg-1 seed. Referring back to Table (4), there was coincidence in the results of seed priming when planted at 4 g liter-1 of Mn with 4 g liter-1 of B which also gives the highest number of pods plant-1 (28.66) in Harir location, but the lowest was (16.33) when planted at 0 g liter-1 of Mn with 0 g liter-1 of B in the same location, this was the yield component that had the most influence on, correlation with seed yield.

Number of seeds pod-1:

Data in Table (4) also shows that the highest number of seeds pod-1 was recorded for the sample collected from 4 g liter-1 of Mn (1.78) and 4 g liter-1 of B (1.57) in Harir location, while the lowest was recorded for 6 g liter-1 of Mn (1.03) and 0 g liter-1 of B (1.17) in Khabat location. Considering the interaction between manganese and boron by seed priming, the highest value (2.00) was obtained for 4 g liter-1 of Mn with 4 g liter-1 of B in both locations, but the lowest value was recorded from 0 g liter-1 of Mn with 0 g liter-1 of B (0.87) from Khabat location.

Weight of 100 seeds (g):

The Table (4) displayed Weight of 100 seeds performed the highest was at planting by seed priming with 4 g liter-1 of manganese (23.04 g) and 4 g liter-1 of boron (20.25) from Harir location, but the lowest was in Khabat location at 0 g liter-1 of Mn (16.50 g) and 0 g liter-1 of B (18.25 g). The highest value was also in Harir location when planted by seed priming at 4 g liter-1 of Mn with 4 g liter-1 of B (25.66 g), but the lowest value was recorded from Khabat location (15.33 g) at 0 g liter-1 of Mn with 0 g liter-1 of B. These results are also in agreed with the findings of Kaisher et al., (2010). Valenciano et al., (2010) and Ahlawat et al., (2007) earlier reported that 100 seed weight was significantly affected due to various micronutrient treatments.

Seed yield (kg ha-1):

The highest seed yield (1955.67 kg ha-1) was recorded when the chickpea seeds were priming with manganese at 4 g liter-1 from Harir location. Regarding boron concentration, the highest value was obtained at 4 g liter-1 (1621.04 kg ha-1) from Khabat location, while the lowest yield was obtained from both concentration at 0 g liter-1 of Mn and 0 g liter-1 of B (1151.66 and 1303.25 kg ha-1) respectively in Khabat location. When seeds primed in the concentration of manganese, marigold statistically produced highest yield, Mirshekari et al., (2012). Farooq et al., (2012) reported that micronutrient application through seed treatments improves the stand establishment, advances phenological events, and increases yield and micronutrient grain contents in most cases. The variations in seed yield, confirm that the interaction between manganese and boron concentrations by seed priming are significant. The superior value was from Harir location at 4 g liter-1 of Mn with 4 g liter-1 of B (2287.70 kg ha-1), whereas the minimum was for Harir location at 0 g liter-1 of Mn with 0 g liter-1 of B (1006.33 kg ha-1) in Khabat location. The reason of the lowest yield at control treatment is the boron deficiency in the soil. Due to severe deficiency of boron may restrict the normal flow of hormone, (Ahlawat et al., 2007).

Protein yield (kg ha-1):

The protein yield results are displayed from Table (4) shows that the highest level (373.60 kg ha-1) was observed at 4 g liter-1 of Mn in Harir location and (315.55 kg ha-1) from Khabat location at 4 g liter-1 of B. While the minimum rate was obtained from Khabat location at 0 g liter-1 of Mn and B (201.83 and 236.02 kg ha-1) respectively. The planting chickpea by seed priming at 4 g liter-1 of Mn with 2 g liter-1 of B recorded the highest yield of protein was in Harir location (438.22 t.ha-1), but the lowest was at 0 g liter-1 of Mn with 0 g liter-1 of B (158.34 t.ha-1) from Khabat location. Increase the level of concentration by manganese and boron up to 6 g liter-1 caused decrease the yield, this result was agreement with Ahlawat et al., (2007) who reported the high rates can cause a reduction in yield, especially in dry conditions.

Effect of seed priming on seed quality of chickpea:

Protein percentage%:

Table (4) shows the protein percentage which was the maximum level at 2 g liter-1 of Mn and 2 g liter-1 of B which was (20.05% and 19.46%) respectively from Harir location. and the minimum was (17.44%) from both location at 6 g liter-1 of Mn and (17.91%) from Harir location at 6 g liter-1 of B. From increase the protein percentage in seed was mostly due to the increase in the Protein yield, whereas the interaction between manganese and boron concentration, the maximum rate was also at 2 g liter-1 of Mn with 2 g liter-1 of B which was (21.32 % and 21.66) respectively from both locations Khabt and Harir, the minimum was at 0 g liter-1 of Mn with 0 g liter-1 of B that was (16.51% and 16.37 %) respectively from both locations.

Oil percentage (%):

Table (5) displayed the oil percentage that obtained the maximum level at 2 g liter-1 of Mn (8.915%) from Khabat location and 2 g liter-1 of B which was (8.30%) from Harir location and the minimum was at 0 was at 0 g liter-1 of Mn which was (6.81%) from Khabat location and (7.315%) from Harir location at 6 g liter-1 of B. The highest value of oil% was obtained at at 2 g liter-1 of Mn with 2 g liter-1 of B which was (9.77 %), and the lowest was at 0 g liter-1 of Mn with 0 g liter-1 of B that was (6.04 %) from Harir location.

Carbohydrate percentage (%):

The highest level of carbohydrate percentage was at 4 g liter-1 of manganese that was (59.22%) from Harir location and (58.72%) at 2 g liter-1 of boron from both locations, and the minimum was at 0 g liter-1 of Mn and 0 g liter-1 of B that was (56.15% and 56.48%) respectively, from Harir location. while the highest optimum rate of interaction between manganese and boron was at 4 g liter-1 of Mn with 2 g liter-1 of B that was (60.67%) and the minimum was at 0 g liter-1 of Mn with 0 g liter-1 of B that was (55.20%) from Harir location.

Nitrogen percentage (N)%:

The nitrogen seed for chickpea was recorded by high percentage at 2 g liter-1 of manganese and 2 g liter-1 of boron which was (3.20% and 3.11%) respectively from Harir location. and the minimum was (2.79%) from both location at 6 g liter-1 of Mn and (2.86%) from Harir location at 0 g liter-1 of B. Increase nitrogen% caused to increase protein% because have the high relation between them. From interaction between manganese with boron from two locations on nitrogen%, shows the higher rate for this trait at 2 g liter-1 of Mn with 2 g liter-1 of B which was (3.41 % and 3.46) respectively from both locations Khabt and Harir, the minimum was at 0 g liter-1 of Mn with 0 g liter-1 of B that was (2.64% and 2.61 %) respectively from both locations.

Phosphor percentage (P2O5) %:

The results explain that the seed of chickpea produced the highest percentage of Phosphor percentage (0.71%) at 4 g liter-1 of Mn and (0.67%) 2 g liter-1 of B from both locations, while the lowest rate for this trait from Khabat and Harir locations recorded (0.59%) at 0 g liter-1 of Mn and (0.63%) 0 g liter-1 of B. The interaction between manganese with boron concentrated had significantly affected phosphor percentage, it was found at 4 g liter-1 of Mn with 2 g liter-1 of B gave the highest value was (0.75%) and the lowest value was (0.56%) at 0 g liter-1 of Mn with 0 g liter-1 of B respectively from both locations.

Potassium percentage (K2O) %:

The data shows existence of significant differences among factors studied the highest potassium percentage (0.78%) at 4 g liter-1 of manganese and 2 g liter-1 of boron, compared with control; 0 g liter-1 of Mn and 0 g liter-1 of B that recorded the lowest rate (0.71 and 72%) respectively from Khabat and Harir locations from Khabat and Harir locations. However, the interaction between manganese and boron concentration was significant, the highest potassium% (0.81%) was observed at 4 g liter-1 of Mn with 2 g liter-1 of B, compared with the inferior interaction the lowest value was (0.69%) at 0 g liter-1 of Mn with 0 g liter-1 of B respectively from both locations.

Table (3): Effect of seed priming with Mn and B on some growth parameters of chickpea.

Traits		Plant height (cm)	Leaf area (cm^2)	Leaf area index (LAI)	Dry matter ($g\ m^2$)	Crop growth rate ($g\ m^2\ day^{-1}$)	Plant height (cm)	Leaf area (cm^2)	Leaf area index (LAI)	Dry matter ($g\ m^2$)	Crop growth rate ($g\ m^2\ day^{-1}$)
Mn (g liter^{-1})		Khabat location					Harir location				
0		32.16 c	519.41 d	1.73 d	33.78 d	5.63 d	32.91 d	538.16 d	1.79 d	33.43 c	5.57 c
2		35.16 b	638.42 b	2.12 b	34.84 c	5.80 c	36.08 c	660.16 b	2.10 b	35.06 b	5.84 b
4		43.41 a	763.75 a	2.54 a	39.34 a	7.10 a	44.91 a	795.25 a	2.65 a	43.48 a	7.24 a
6		42.91 a	559.08 c	1.86 c	35.66 b	5.94 b	42.25 b	568.66 c	1.89 c	34.73 b	5.79 b
B (g liter^{-1})											
0		35.91 d	570.83 d	1.90 d	32.09 c	5.34 c	36.91 c	592.16 c	1.97 c	32.20 d	5.36 c
2		37.91 c	631.00 b	2.10 b	38.85 a	6.47 a	38.75 b	659.91 b	2.20 b	39.03 b	6.50 a
4		40.75 a	691.91 a	2.30 a	39.38 a	6.56 a	41.66 a	720.33 a	2.40 a	42.65 a	6.55 a
6		39.08 b	586.91 c	1.95 c	36.61 b	6.10 b	38.83 b	589.83 c	1.96 c	36.12 c	6.02 b
Mn x Boron											
0	0	30.33 j	422.33 j	1.40 j	25.11 i	4.18 i	31.33 h	448.00 l	1.49 k	25.62 l	4.27 k
	2	31.33 ij	506.00 h	1.67 h	36.25 e	6.04 e	32.00 h	530.00 i	1.76 h	36.16 gh	6.02 fg
	4	34.66 h	644.00 e	2.14 ef	37.88 d	6.31 d	35.66 g	673.00 e	2.24 d	37.95 e	6.32 e
	6	32.33 i	508.00 h	1.69 h	35.89 e	5.98 e	32.66 h	501.00 j	1.67 i	34.00 i	5.66 h
2	0	30.66 j	561.66 g	1.87 g	28.52 h	4.75 h	31.33 h	580.00 h	1.93 g	29.03 k	4.84 j
	2	34.66 h	626.00 f	2.08 f	34.29 f	5.71 f	36.00 fg	673.00 e	2.24 d	35.40 h	5.90 g
	4	36.33 g	716.00 d	2.38 d	39.95 d	6.49 d	37.33 ef	754.33 d	2.51 cd	39.33 d	6.55 d
	6	39.00 f	650.00 e	2.17 e	37.59 d	6.26 d	39.66 d	633.00 f	2.11 f	36.48 fgh	6.08 fg
4	0	40.33 e	737.66 c	2.45 c	36.07 e	6.01 e	42.00 c	764.66 c	2.54 c	36.77 fg	6.13 fg
	2	42.33 cd	768.66 b	2.56 b	46.95 a	7.82 a	43.33 bc	785.00 b	2.62 b	46.11 b	7.67 b
	4	47.66 a	831.33 a	2.77 a	45.33 b	7.55 b	50.00 a	880.00 a	2.93 a	48.22 a	8.03 a
	6	43.33 bc	717.33 d	2.39 d	42.66 c	7.04 c	44.33 b	751.33 d	2.50 cd	42.81 c	7.13 c
6	0	42.33 cd	561.66 g	1.87 g	38.66 d	6.44 d	43.00 bc	576.00 h	1.92 g	37.37 ef	6.23 ef
	2	43.33 bc	626.00 f	2.08 f	37.92 d	5.89 ef	43.66 c	651.66 g	2.17 e	36.33 fgh	6.05 efg
	4	44.33 b	576.33 g	1.92 g	35.37 ef	6.32 d	43.66 c	573.00 h	1.91 g	34.00 i	5.66 h
	6	41.66 d	472.33 i	1.57 i	30.70 g	5.12 g	38.66 de	473.33 k	1.57 j	31.22 j	5.20 i

Means the same letters are not significant difference.

Table (5): Effect of seed priming with Mn and B on seed quality of chickpea.

Traits		No. of primary branches $plant^{-1}$	No. of pod $plant^{-1}$	No. of seeds pod^{-1}	Weight of 100 seeds (g)	Seed yield (kg ha^{-1})	Protein yield (kg ha^{-1})	No. of primary branches $plant^{-1}$	No. of pod $plant^{-1}$	No. of seeds pod^{-1}	Weight of 100 seeds (g)	Seed yield (kg ha^{-1})	Protein yield (kg ha^{-1})
Mn (g $liter^{-1}$)		Khabat location						Harir location					
0		2.86 d	20.25 d	1.17 c	16.50 d	1151.66 d	201.83 d	2.89 d	20.50 d	1.29 c	17.25 d	1221.00 d	214.06 d
2		3.54 b	23.41 b	1.43 b	18.83 b	1572.22 b	314.03 b	3.71 b	24.00 b	1.56 b	19.41 b	1542.47 b	310.27 b
4		3.84 a	25.10 a	1.72 a	22.62 a	1949.19 a	372.18 a	3.82 a	26.00 a	1.78 a	23.04 a	1955.67 a	373.60 a
6		3.11 c	20.86 c	1.03 d	18.50 c	1293.00 c	231.86 c	2.99 c	22.27 c	1.24 c	18.25 c	1292.50 c	231.34 c
B (g $liter^{-1}$)													
0		2.93 d	22.19 b	1.17 d	18.25 c	1303.25 c	236.02 d	3.06 d	20.50 c	1.30 b	18.33 b	1327.83 d	240.04 d
2		3.41 b	22.76 ab	1.39 b	19.33 b	1530.66 b	296.98 b	3.37 b	23.75 b	1.45 a	19.82 ab	1575.66 b	305.11 b
4		3.81 a	23.19 a	1.49 a	19.95 a	1621.04 a	315.55 a	3.75 a	24.44 a	1.57 a	20.25 a	1613.96 a	314.64 a
6		3.21 c	20.83 c	1.32 c	18.91 b	1511.11 b	271.36 c	3.23 c	23.28 b	1.55 a	18.75 b	1494.18 c	269.49 c
Mn x Boron													
0	0	2.46 j	21.00 fg	1.10 ghi	15.33 j	1006.33 j	158.34 h	2.55 g	22.66 fg	1.36 def	16.33 jk	1023.33 m	164.24 k
	2	2.66 ij	20.44 g	1.16 fgh	16.33 ij	1244.00 h	228.94 f	2.55 g	21.77 f	1.30 defg	17.66 i	1269.00 i	233.53 h
	4	3.33 de	23.00 de	1.26 ef	17.66 gh	1514.33 f	274.72 e	3.44 de	24.33 de	1.37 def	18.66 h	1547.66 f	281.88 f
	6	3.00 gh	19.00 h	1.19 fg	16.66 hi	1247.66 h	221.23 fg	3.07 f	20.33 g	1.13 efg	16.33 jk	1202.00 j	209.15 i
2	0	3.22 fg	22.00 ef	1.17 fgh	16.66 hi	1515.41 f	274.91 e	3.55 d	22.66 fg	1.31 defg	17.00 ij	1415.41 g	261.52 g
	2	3.51 efg	23.66 cd	1.34 e	18.33 fg	1644.48 e	350.71 c	3.84 c	25.33 cd	1.44 cde	18.66 h	1544.48 f	334.53 d
	4	3.80 bcd	24.66 bc	1.70 c	20.33 d	1755.66 d	365.35 bc	3.88 c	26.33 c	1.80 ab	21.66 cd	1877.33 c	362.44 c
	6	3.65 cde	23.33 cde	1.52 d	20.00 de	1373.33 g	265.11 e	3.58 d	21.66 f	1.69 abc	20.33 ef	1440.00 g	282.59 f
4	0	2.84 hi	23.43 cd	1.33 e	21.66 c	2044.73 b	377.03 b	2.88 f	24.66 de	1.51 bcd	22.00 c	1770.00 d	367.26 c
	2	3.95 dc	25.66 b	1.87 b	22.82 b	1845.00 c	373.62 b	4.10 ab	27.00 b	1.80 ab	23.50 b	1991.66 b	385.75 b
	4	4.50 a	27.66 a	2.00 a	24.33 a	2274.36 a	437.77 a	4.25 a	28.66 a	2.00 a	25.66 a	2287.70 a	438.22 a
	6	4.10 b	23.66 cd	1.69 c	21.66 c	1632.66 e	299.31 d	4.06 b	23.66 ef	1.80 ab	21.00 de	1666.00 e	304.17 e
6	0	3.22 fg	23.33 cde	1.07 hi	19.33 def	1318.33 g	230.81 f	3.33 e	22.33 f	1.03 efg	19.66 fg	1418.33 g	248.40 g
	2	3.51 efg	23.00 de	1.20 fg	18.33 fg	1321.33 g	243.76 f	3.00 g	23.66 ef	1.26 defg	19.00 gh	1354.66 h	253.30 g
	4	3.62 bcd	18.33 hi	1.00 i	19.00 ef	1166.00 h	202.57 g	3.44 de	19.66 g	1.10 efg	18.66 h	1151.33 k	200.81 ij
	6	2.10 k	17.33 i	0.87 j	17.33 ghi	1017.66 i	174.26 h	2.22 h	16.33 h	1.58 bcd	15.66 k	1107.66 l	190.33 j

Means the same letters are not significant difference.

Traits		Protein %	Oil %	Carbohydrate %	N %	P_2O_5	K_2O %	Protein %	Oil %	Carbohydrate %	N %	P_2O_5	K_2O %
Mn (g liter^{-1})		Khabat location						Harir location					
0		17.44 d	6.81 d	56.32 c	2.79 d	0.59 c	0.71 d	17.44 d	6.87 d	56.15 d	2.79 d	0.59 c	0.71 d
2		19.89 a	8.91 a	58.50 a	3.18 a	0.65 b	0.75 b	20.05 a	8.85 a	58.17 b	3.20 a	0.65 b	0.75 b
4		19.07 b	8.02 b	58.91 a	3.05 b	0.71 a	0.78 a	19.08 b	8.13 b	59.22 a	3.05 b	0.71 a	0.78 a
6		17.91 c	7.26 c	57.33 b	2.86 c	0.64 b	0.73 c	17.86 c	7.20 c	57.37 c	2.85 c	0.64 b	0.73 c
B (g liter^{-1})													
0		17.86 b	7.33 d	56.96 b	2.87 b	0.63 b	0.72 c	17.91 c	7.31 d	56.48 c	2.86 c	0.63 c	0.72 c
2		19.36 a	8.19 a	58.72 a	3.09 a	0.67 a	0.77 a	19.46 a	8.30 a	58.72 a	3.11 a	0.67 a	0.77 a
4		19.12 a	7.89 b	58.11 a	3.05 a	0.66 a	0.75 b	19.10 b	7.93 b	58.25 b	3.05 b	0.66 b	0.75 b
6		17.96 b	7.58 c	57.27 b	2.85 b	0.64 b	0.73 c	17.96 c	7.51 c	57.10 c	2.87 c	0.64 c	0.73 c
Mn x Boron													
0	0	16.51 f	6.08 g	55.53 g	2.64 f	0.56 g	0.69 g	16.37 g	6.04 j	55.20 f	2.61 g	0.56 i	0.69 h
	2	18.40 cd	7.44 de	56.77 efg	2.94 cd	0.59 g	0.72 ef	18.40 e	7.33 h	56.44 f	2.94 e	0.58 i	0.77 bc
	4	18.14 de	7.73 cd	57.36 def	2.90 de	0.61 f	0.74 de	18.21 e	7.87 ef	57.69 de	2.91 e	0.61 hi	0.74 e
	6	17.73 de	7.26 e	55.61 g	2.83 de	0.60 f	0.73 ef	10.40 f	7.15 h	55.28 f	2.78 f	0.60 hi	0.73 f
2	0	18.12 de	8.29 b	57.89 cdef	2.90 de	0.62 f	0.73 e	18.47 e	8.24 d	57.56 e	2.95 e	0.62 g	0.77 bc
	2	21.32 a	9.63 a	59.91 ab	3.41 a	0.65 de	0.78 bc	21.66 a	9.77 a	59.58 b	3.46 a	0.65 ef	0.79 b
	4	20.81 ab	9.24 a	58.69 bcd	3.33 ab	0.68 c	0.77 c	20.47 b	9.05 b	58.36 c	3.27 b	0.68 d	0.78 b
	6	19.25 c	8.47 b	57.51 def	3.08 c	0.67 c	0.76 c	19.62 c	8.33 cd	57.18 e	3.13 c	0.67 de	0.73 f
4	0	18.42 cd	8.06 bc	57.88 cdef	2.95 cd	0.66 cd	0.75 c	18.44 e	8.10 de	58.21 cd	2.95 e	0.66 e	0.72 fg
	2	19.29 c	8.35 b	60.34 a	3.08 c	0.75 a	0.81 a	19.11 cd	8.53 c	60.67 a	3.05 cd	0.75 a	0.81 a
	4	20.25 b	8.18 b	59.25 abc	3.24 b	0.74 a	0.79 b	20.55 b	8.18 d	59.49 b	3.28 b	0.73 b	0.77 bc
	6	18.33 d	7.75 de	58.18 cde	2.93 d	0.71 b	0.74 de	18.25 e	7.73 fg	58.51 c	2.92 e	0.71 c	0.74 e
6	0	17.51 de	7.37 de	57.77 def	2.80 de	0.71 b	0.73 e	17.51 f	7.22 h	57.44 e	2.80 f	0.72 c	0.72 fg
	2	18.44 cd	7.34 de	57.86 cdef	2.95 cd	0.67 c	0.74 de	18.69 de	7.59 g	58.20 cd	2.99 de	0.68 d	0.74 e
	4	17.37 ef	6.61 f	57.14 ef	2.78 ef	0.64 e	0.71 g	17.44 f	6.62 i	57.47 e	2.79 f	0.64 f	0.71 gh
	6	17.29 ef	6.43 fg	56.54 fg	2.74 ef	0.57 g	0.70 g	17.18 f	6.47 i	56.40 f	2.74 f	0.57 i	0.70 h

Means the same letters are not significant difference.

CONCLUSIONS

From the results of this research elucidated that chickpea is a highly responsive to seed priming by micronutrient in manganese and boron in particular and their deficiencies may be one of the important reason of poor yield, the heights of more characteristics of parameters, yield and yield components recorded at 4 g liter-1 of Mn and 4 g liter-1 of B and seed quality at 2 g liter-1 of Mn and 2 g liter-1 of B in Harir location compared with Khabat location, due to both locations are difference in environment from temperature and rain caused to more the stay in the field to increase the yield.

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CONFLICT OF INTEREST

The author declares no conflicts of interest regarding the publication of this article.

تأثير تحضير البذور بالمنغنيز والبورون على النمو وإنتاجية ونوعية بذور الحمص (Cicer arietinum L.)

بلال إبراهيم محمد
قسم انتاج النبات / معهد تقني خبات / جامعة أربيل التقنية / العراق

الخلاصة

أجريت هذه الدراسة في موقعين؛ حقل المعهد التقني خبات – جامعة أربيل التقنية وحقل دائرة الزراعة في حرير– أربيل ، خلال الموسم الربيعي 2021. لدراسة تأثير تحضير البذور بالمنغنيز والبورون على النمو والحاصل ونوعية بذور الحمص. استخدم تصميم القطاعات الكاملة العشوائية (RCBD) بثلاثة مكررات في تنفيذ التجربة، يمثل العامل الأول تحضير البذور وذلك بنقعها بأربعة تركيزات من المنغنيز: (0 ، 2 ، 4 ، 6 غم لتر −1) والعامل الثاني البورون (0 ، 2 ، 4 , 6 غم لتر −1). أدى تحضير البذور بالمنغنيز بتركيز 4 غم لتر −1 والبورون بتركيز 4 غم لتر −1 في موقع حرير إلى تفوق معنوي في الصفات: ارتفاع النبات (سم)، مساحة الورقة (سم 2)، دليل المساحة الورقية، المادة الجافة (غم. م−2) ، عدد القرنات. نبات−1 ، عدد البذور. القرنة −1 ، وزن 100 بذرة (غم) ، حاصل البذور (كغم. هكتار−1) حاصل البروتين (كغم. هكتار−1) . سجلت نسبة زيادة البروتين٪، الزيت٪ والنيتروجين٪ عند 2 غم لتر−1 من المنغنيز و بورون، بينما سجلت زيادة نسبة الكربوهيدرات٪ والفوسفور ٪ والبوتاسيوم٪ عند 4 غم لتر−1 من المنغنيز و 2 غم لتر−1من بورون من كلا الموقعين. كانت القيمة المتفوقة للتداخل بين تراكيز المنغنيز والبورون من موقع حرير عند 4 غم لتر−1 من المنغنيز مع 4 غم لتر−1 من بورون لجميع صفات النمو والحاصل ومكوناته, ولكن زيادة نسبة البروتين٪ و الزيت٪ النيتروجين٪ تم تسجيله من تداخل المنغنيز مع البورون عند 2 غم لتر−1 ، بينما تم تسجيل زيادة

نسبة الكربوهيدرات٪ والفوسفور ٪ والبوتاسيوم٪ عند استخدام 4 غم لتر−1 من المنغنيز مع 2 غم لتر−1 من البورون في كلا الموقعين.

الكلمات المفتاحية: الحمص، تحضير البذور، المنغنيز، البورون والحاصل.

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