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Effect of Micronutrients (Zn, B and Mo) Foliar Application at Various Growth Stages of Chickpea (*Cicer arietinum* L.) on Yield and Yield Components

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ABSTRACT

Two field trials were conducted during 2015/16 and 2016/17 winter seasons, at Agric. Res. Stat., Fac. Agric., Cairo Univ., Giza, Egypt, to study response yield and its attributes of chickpea to zinc (Zn), Boron (B) and molybdenum (Mo) in four combination at three growth stages; V_3: vegetative stage (30 days after planting), R_1: start of flowering (45 days after planting) and R_6: pod initiation (60 days after planting). The treatments of micronutrients foliar application were T_1 (application with tap water), T_2 (Zn 0.5 g/l + B 0.5 g/l), T_3 (Zn 0.5 g/l + Mo 0.5 g/l), T_4 (B 0.5 g/l + Mo 0.5 g/l), T_5(Zn 0.5 g/l + B 0.5 g/l + Mo 0.5 g/l). The T_5 treatment (Zn + B + Mo) produced significantly the greatest seed yield feddan^{-1} (702 and 727 kg), stover yield feddan^{-1} (2275 and 2276 kg), harvest index (23.6 and 24.1%) respectively, in both seasons. The results indicated that the spraying time of microelements did not significantly effect on yield traits in 2015/16 and 2016/17 seasons. The greatest productivity of seed (705 and 732 kg/ fed.) in 2015/16 and 2016/17 seasons, respectively was recorded by combined application of zinc (0.5 g/l) + Boron (0.5 g/l) + molybdenum (0.5 g/l) as foliar spray at start of flowering stage compared with other tested treatments. Combined application of zinc, boron and molybdenum as foliar spray at 45 DAP significantly enhanced the crop yields and protein (%) in seed of chickpea.

***Keywords**:* Chickpea, foliar application, flowering, yield, protein.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important pulses crops in world and Egypt as it offers protein for human nutrition. Despite its uses, the area cultivated with chickpeas is continuously decreasing. The world's total production of chickpea was12, 092,950 tons annually, harvested area was 12,650,078 ha and the average yield was 956 kg/ha in the world (Anonymous, 2019). In Egypt, the amount of chickpea production was 3271 tons, harvested area and yield was 1503 hectare and 2176.2 kg/ha, respectively (Anonymous, 2019). The gap between consumption and production was filled by imports. Foliar application of molybdenum (Mo) at 30 DAS improved chickpea yield (Valenciano *et al.* 2011). According to Bejandi *et al.* (2012) increasing in flower numbers, pod set improvement, and reduction in days to flowering is affected by molybdenum. Moreover, using zinc foliar application increase grain yield and seed protein content up to 25 and 40%, respectively (Bejandi *et al.* 2012 and Pathak *et al.* 2012). Ganga *et al.* (2014) mentioned that foliar application with 0.25% multiplex at pre-flowering stage gave the highest growth, seed yield and monetary advantage in chickpea under late sown condition. Also, Sarbandi and Madani (2014) mentioned that micro-nutrients special Zn could have significant role in improving the yield and dependent characteristics in chickpea that helped in enhancing productivity of chickpea. Rahman *et al.* (2017) reported that foliar application of micronutrients mixtures (Zn, Fe, Mg, Cu, B and Mn) in combination with nitrogen improved the plant growth, yield and yield attributes were number of pods plant^{-1}, number of seed plant^{-1}, and seed weight plant^{-1}. The same application also produced maximum seed yield ha^{-1} harvest index and 100-seed weight. Kachave *et al.* (2018) indicated that foliar application by multi micronutrients gave the maximum seed yield and seed protein content of chickpea. Also, Menaka *et al.*(2018) found that spray of boron resulted in an increase of 24.7 and 12.6% in pod number plant^{-1} ad 100 seed weight respectively. The main objectives of recent work were to evaluate the response of chickpea to zinc (Zn), boron (B) and molybdenum (Mo) at different times of application.

MATERIALS AND METHODS

Two field trials were carried out at the Agricultural Experimental Research Station, Faculty of Agriculture, Cairo University during the seasons 2015/2016 and 2016/2017 to study effects of zinc (Zn), boron (B) and molybdenum (Mo), in four combination at three growth stages of application; V_3: vegetative stage (30 days after planting), R_1: start of flowering (45 days after planting) and R_6: pod initiation (60 days after planting) on yield and its attributes of chickpea Giza 531 cultivar. Foliar application

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treatments were adopted as follows: T_1: Control (spray tap water), T_2: zinc @ 0.5 g/L + boron @0.5 g/L , T_3: zinc @0.5 g/L + molybdenum @0.5 g/L, T_4:boron @0.5 g/L + molybdenum @ 0.5 g/L, T_5: zinc @ 0.5 g/L + boron @0.5 g/L + molybdenum @0.5 g/L. By using hand sprayer (1L), the chickpea plants received three sprays of solutions contained 0.5 g/L from each microelement at 30, 45 and 60 days after planting (DAP), zinc chelate (14% Zn), molybdenum chelate (5% Mo) and Boraxe ($Na_2B_4O_7$, $10H_2O$) 5% boron. The solution of spray was 400 litre feddan^{-1}.The experimental design was a split plot in RCB arrangement with three replications in both seasons. The experimental unit contain five ridges spaced 60 cm apart with 4 meters long (12 m^2). The main plots were allocated to the five micronutrients foliar application. While, foliar application times occupied the subplots. An alley of one meter apart was left between plots to prevent overlapping. The preceding summer crop was maize (*Zea mays* L.*)* in both seasons of study. Sowing date was on 24th and 21th November in the first and second seasons, respectively. Chickpea seeds "Giza 531" cultivar were inoculated immediately before sowing with a culture broth containing *Rhizobium ciceri*. All other agronomic practices were applied as recommended.

Table1. Soil analysis in 2015/2016 and 2016/2017 seasons.

Season	Clay	Silt	Sand	Organic	pH	Salinity	N	P	K	Zn	Fe	Mo	Cu
	%	%	%	%	-	ds.m^{-1}	ppm	ppm	ppm	ppm	ppm	ppm	ppm
2015/16	38.9	23.1	38.0	1.9	7.8	0.87	39	16.7	220	0.67	13.1	3.4	0.59
2016/17	38.2	24.3	37.5	1.8	7.9	0.78	38	15.4	211	0.53	12.8	3.2	0.56

Yield traits

At harvest the following characteristics was estimated,

(1) Plant length (cm),
(2) Branches No./ plant,
(3) Pods No./ plant,
(4) Seed index; 100-seed weight (g)
(5) Seed weight/ plant (g),
(6) Seed yield/feddan (kg),
(7) Stover yield/feddan (kg),
(8) Harvest index (%) was calculated as follow:

$$\textbf{Harvest index} = \frac{\textbf{Seed weight (kg)}}{\textbf{Biological yield}} \times 100$$

Seed nitrogen content was estimated according the micro-kjeldahl method of AOAC (1990). Protein (%) was calculated by multiplying N content by 6.25 according to Chapman and Pratt (1978).

Data were subjected to analysis of variance according to Steel and Torrie (1997). Means of treatments were compared based on least (LSD) at probability level of 5% according to Snedecor and Cochran (1990). Statistical analysis was done by "MSTAT-C" statistical software package 8.1 (University of Michigan State, 1983).

RESULTS AND DISCUSSION

1. Effect of micro-nutrient foliar application

Perusal of data tabulated in Table (2) revealed that foliar application treatment was significantly increased plant height in 2015/2016 and 2016/2017 seasons. The tallest chickpea plants (72.2 and 74.2 cm) were recorded by the T_5 treatment (Zn+B+Mo) and the shortest plants (54.7 and 55.2 cm) was recorded by the T_1 treatment (control) in both seasons. Similar finding was also reported by Yadav *et al.* (2010), Nandaniya *et al.*(2016) Islam *et al.* (2018) and Jadhav *et al.* (2019). The increase in plant length might be attributed to the role of foliar application in the synthesis of IAA, metabolism of auxins, biological activity, stimulating effect on enzyme activity and photosynthetic pigments which in turn encourage vegetative growth of plants (Michail *et al.* 2004). On the other hand, micronutrient foliar application was not only effective on plant height (Thalooth *et al*., 2006, Hu *et al*., 2008 and Kobraee 2019).

Results depicted in Table (2) confirm that micronutrients' significantly effect on branches No. /plant in 2015/16 and 2016/17 seasons. The maximum branches No. /plant (4.30 and 4.37) was recorded by the T_5 treatment in both seasons, respectively. The lowest number of branches plant^{-1} (2.47 and 2.50) was recorded from the T_1 (control) treatment in2015/16 and 2016/17 seasons, respectively. Similar results were reported by Yadav *et al.* 2010, Ganga *et al.* 2014, Nandaniya *et al*., 2016 and Jadhav *et al*., 2019).

Data regarding number of pods No. /plant of chickpea as influenced by different micronutrient applications in 2015/16 and 2016/17 seasons are shown in Table (2). The highest pods No./plant (70.4 and 70.8) was recorded from T_5 treatment, while the lowest (55.7 and 55.9) was recorded from T_1 (application tap water) treatment in 2015/16 and 2016/17 seasons. The previous results indicate that Zn, B and Mo microelements have a signficant effect on the pods No./plant of chickpea. T_5 treatment increased pod set by 26.4% over the control tratment (Table 2). This may be due to the role of Zn, B and Mo in the production of (IAA) indole acetic acid, which may have resulted in more flowers plant^{-1}. Jadhave *et al.*(2019)reported that the increase in pods No. /plant as a result to spraying of nutrients could be due to significant effect of micronutrients on organs of reproductive such as pollens and stamens. Stamens activity enhances the number of flowers that can fertile well and as a result, large pods No. /plant produced. Similar findings are in close conformity with those obtained by of Ganga *et al.* (2014), Rhaman *et al.* (2017) and Islam *et al.* (2018). However, Bozoglu *et al.* (2007) obtained contrary results, in their work pods No. /plant decreased with the application spray of Mo.

Seed index of chickpea was significantly increased by various foliar application trials in 2015/2016 and 2016/2017 seasons (Table 2). The greatest seed index (26.6 and 28.6 g) was obtained from the T_5 treatment and the lowest (18.5 and 18.9 g) was recorded from the T_1 (control) treatment. These results are in conformity with the work of Valenciano *et al.* (2010), Karan *et al.* (2014), Nasar and Shah (2017), Rhaman *et al.* (2017) Islam *et al.* (2018) and Kobraee (2019) who reported that heaviest 1000-seed weight of chickpea was obtained by applied Mo and Fe microelements.

Table 2. Effect of microelements foliar application on yield attributes components of chickpea in 2015/16 and 2016/17 seasons.

Traits	Season	Foliar application treatments				
		T_1 (Tap Water)	T_2 (Zn+ B)	T_3 (Zn+Mo)	T_4 (B +Mo)	T_5 (Zn+B+Mo)
Plant length (cm)	2015/16	54.7 a	64.7 b	65.7 bc	67.3 c	72.2 c
	2016/17	55.2 a	65.5 b	66.3 b	68.5 b	74.2 c
Branches/plant (No)	2015/16	2.47 a	3.53 b	3.63 bc	3.90 c	4.30 c
	2016/17	2.50 a	3.73 b	3.93 b	4.20 c	4.37 c
Pods/plant (No)	2015/16	55.7 a	65.8 b	67.3 bc	69.2 c	70.4 c
	2016/17	55.9 a	66.6 b	68.4 b	69.6 bc	70.8 c
Seed index (g)	2015/16	18.5 a	23.1 b	24.4 bc	25.6 c	26.6 c
	2016/17	18.9 a	22.8 b	23.6 b	25.9 c	28.6 d
Seeds /plant (g)	2015/16	10.2 a	11.4 b	12.4 b	14.6 c	15.6 c
	2016/17	11.2 a	12.4 b	14.4 b	15.6 c	16.9 d
Seed yield /fed (Kg)	2015/16	568 a	626 b	667 b	685 c	702 c
	2016/17	574 a	633 b	676 b	696 c	727 d
Stover yield/ fed. (kg)	2015/16	2033 a	2157 b	2192 b	2217 c	2275 c
	2016/17	2034 a	2157 b	2192 b	2217 c	2276 d
Harvest index (%)	2015/16	21.8 a	22.5 b	23.3 bc	23.6 c	23.6 c
	2016/17	22.2 a	22.7 b	23.6	23.9 bc	24.1 c
Protein (%)	2015/16	17.4 a	18.4 b	18.4 b	19.2 c	19.7 c
	2016/17	17.6 a	18.8 b	19.3 bc	19.7 c	19.9 c

***Means followed by the same letter(s) in rows are not significantly different.**

Results of seed yield /plant of chickpea (Table 2) in 2015/2016 and 2016/2017 seasons, showed significant differences among microelements spray treatments. T_5 treatment gave the highest seed yield /plant (15.6 and 16.9 g), while minimum seed yield plant^{-1}(10.2 and 11.2 g) was recorded in T_1 application in both seasons, respectively. The present findings are corroborating with the reports of Hafiz *et al.* (2004), Siavashi *et al.* (2004), Burman *et al.* (2007) Solanki and Sahu (2007), Yadav *et al.* (2010), Pathak *et al.* (2012), and Nandaniya *et al.* (2016).

The results from Table (2) showed that the differences between foliar application of microelements (Zn , B and Mo) were significant differ in the seed yield (kg feddan^{-1}) of chickpea in 2015/2016 and 2016/2017. While, the greatest increase in seed yield (kg feddan^{-1}) was recorded in T_5 treatment. It was observed that the greatest seed yield (702 and 724 kg /feddan) was recorded with treatment T_5 which was similar statistically with T_4 and significantly superior over the rest of the treatments. The lowest seed yield (568 and 574 kg /feddan) was recorded by the control treatment (T_1). The increase in seed yield (kg /feddan) varied from 10.2 to 23.6% at various foliar application treatments compared with the control treatment (T_1). The higher seed yield of chickpea (kg feddan^{-1})was observed with foliar application with (Zn, B and Mo) due to their positive influence on pod set, number of pods plant^{-1}, pod weight, 100-seed weight and mobilization of assimilate reserves to the sink. Similar findings were also reported by Valenciano *et al.* (2010), Valenciano *et al.* (2011), Ganga *et al.* (2014),Sarbandi and Madani (2014),Nandaniya *et al.* (2017)Nasar and Shah (2017), Menaka *et al.* (2018), Jadhav *et al.* (2019) and Kobraee (2019).

Data regarding stover yield (kg /feddan) of chickpea revealed that spray application treatments significantly increased stover yield of chickpea over control treatment (Table 2) in 2015/2016 and 2016/2017 seasons. The maximum value of straw yield (2275 and 2276 kg feddan^{-1}) was recorded from T_5 treatment in both seasonse, respectively; this was somewhat statistically similar with other treatments (T_3 and T_4). This potential increase of straw yield of chickpea with foliar application micronutrients might be due to the contribution of growth and yield attributes. The above results are in agreement with those reported by Valenciano *et al.* (2011), Sarbandi and Madani (2014), Ganga *et al.* (2014), Nandaniya *et al.* (2016), Nasar and Shah (2017), Rahman *et al.* (2017) and Kobaraee (2019) who stated that zinc, boron and molybdenum drastically improved straw yield of chickpea and lentil.

Results in Table (2) showed that foliar application treatments had a significant effect on harvest index of chickpea in 2015/2016 and 2016/2017 seasons. Adding of micronutrients could be increase harvest index by 8.2% in Zn+B+Mo treatment (T_5) as compared to control treatment (T_1).That reason of this is increasing of seed yield more than biological yield (Table 2). The greatest value of harvest index (23.6 and 24.1%) was recorded in treatment T_5 (Zn +B+Mo) in both seasons, respectively. Thus increasing of seed yield could improve harvest index. The previous results are in closed with those of Sarbandi and Madani (2014), Ganga *et al.* (2014), Rahman *et al.* (2017), Nasar and Shah (2017) and Kobaraee (2019).

Foliar application of Zn, B and Mo in combination significantly increased seed protein (%) of chickpea seed in 2015/2016 and 2016/2017 seasons (Table 2). The greatest protein content (19.7 and 19.9%) was produced from T_5 treatment in both seasons, respectively. While, T_1 (spray water tap) gave the lowest value of seed protein content (17.4%). The results of the present research are in agreement with the findings of Bejandi *et al.* (2012), Islam *et al* (2018), Kachave *et al.* (2018) and Kobaraee (2019) who reported that application of Mo, Zn, B K, and S enhanced the seed protein content of pulses.

2. Timing of foliar application

Table (3) show that the effect of three different times of foliar application (V_3: vegetative stage at 30 DASP , R_1: start of flowering at45 DAP and R_6: pod formation at 60 DAP) on plant length, number of branches plant^{-1}, number of pods plant^{-1}, 100-seed weight (seed index), seed weight

/plant, seed yield /feddan, stover yield /feddan harvest index , seed protein content in 2015/2016 and 2016/2017 seasons, respectively.

The time of micronutrient application had no significant on plant length, number of branches plant^{-1}, number of pods plant^{-1}, 100-seed weight (seed index), seed weight plant^{-1}, seed yield feddan^{-1}, stover yield feddan^{-1}, harvest index , seed protein content in 2015/2016 and 2016/2017 seasons (Table 3).

Table 3. Response of yield and yield traits of chickpea to different times of foliar application on in 2015/2016 and 2016/2017 seasons

Traits	Season	Times of foliar application			$LSD_{0.05}$
		Vegetative stage	Flowering start	Pod formation	
Plant length (cm)	2015/2016	63.7	66.3	64.8	ns**
	2016/2017	65.3	66.8	65.7	ns
Branches/plant (No)	2015/2016	3.58	3.66	3.46	ns
	2016/2017	3.80	3.70	3.74	ns
Pods/plant (No)	2015/2016	63.2	66.7	67.0	ns
	2016/2017	65.7	66.7	66.3	ns
Seed index (g)	2015/2016	23.9	23.88	23.2	ns
	2016/2017	24.5	23.5	23.9	ns
Seeds /plant (g)	2015/2016	12.9	13.0	12.6	ns
	2016/2017	14.3	14.2	13.8	ns
Seed yield /fed Kg)	2015/2016	641	655	651	ns
	2016/2017	655	664	667	ns
Stover yield/fed(kg)	2015/2016	2164	2186	2175	ns
	2016/2017	2164	2186	2175	ns
Harvest index (%)	2015/2016	22.8	23.0	23.0	ns
	2016/2017	22.8	23.0	23.0	ns
Protein (%)	2015/2016	18.6	18.6	18.8	ns
	2016/2017	19.1	19.0	19.0	ns

*** V_3: vegetative stage at 30 days after planting, R_1: start of flowering at 45 days after planting and R_6: pod initiation at 60 days after planting)**
****ns= Not significant**

3. Interaction effect between foliar application × times of application

There were significant interaction effect between foliar application treatments and time of application on yield and their attributes in 2015/16 and 2016/17 seasons (Table 4). The T_5 treatment produced the tallest plants (74.5 and 76.5 cm), branches No. /plant (4.4 and 4.4),pods /plant (71.4 and 71.4), seed index (27.0 and 29.0 g), seed /plant (16.5 and 17.5 g), seed /feddan (705 and 725 kg), stover /feddan (2287 and 2297 kg), harvest index (23.8 and 24.0 %) and seed protein content (19.8 and 19.9%) at R_1 growth stage (45 days after planting) in both seasons, respectively, compared with T_1 (control treatment).

Table 4. Effect of foliar application at different growth stages of chickpea on yield traits (2015/ 16 and 2016/17 seasons)

Traits	Season*	Foliar application treatments															$LSD_{0.05}$
		T_1(Control)			T_2: (Zn+B)			T_3: (Zn+ Mo)			T_4: (B+ Mo)			T_5: (Zn+ B+ Mo)			
		Growth stages of foliar application**															
		V_3	R_1	R_6	V_3	R_1	R_6	V_3	R_1	R_6	V_3	R_1	R_6	V_3	R_1	R_6	
Plant length (cm)	1st	51.7	55.7	56.7	63.1	66.0	64.9	64.9	67.2	65.1	67.1	68.2	66.7	71.8	74.5	70.4	1.32
	2nd	53.7	55.4	56.5	64.1	66.4	65.9	65.9	66.9	66.1	69.1	68.8	67.7	73.8	76.5	72.4	2.32
Branches/plant (No)	1st	2.20	2.50	2.70	3.80	3.50	3.3	3.70	3.80	3.40	4.0	4.1	3.6	4.2	4.4	4.3	0.32
	2nd	2.30	2.50	2.70	3.90	3.60	3.70	4.10	3.90	3.80	4.30	4.10	4.20	4.40	4.40	4.30	0.21
Pods/plant (No)	1st	56.7	54.9	55.6	60.6	67.2	89.9	63.0	69.2	69.8	66.9	70.8	69.8	69.0	71.4	70.9	1.81
	2nd	56.2	55.9	55.6	66.6	67.2	65.9	67.0	69.2	69.1	8.9	69.8	69.8	70.0	71.4	70.9	2.84
Seed index (g)	1st	18.0	18.1	19.5	23.5	23.5	22.3	25.0	24.5	23.7	26.3	26.3	24.2	26.5	27.0	26.3	1.01
	2nd	18.4	18.8	19.6	23.9	21.8	22.7	24.4	22.6	23.7	26.3	25.3	26.2	29.5	29.0	27.3	2.01
Seeds /plant (g)	1st	10.9	10.0	9.80	11.3	11.8	11.1	12.8	12.2	12.3	14.5	14.6	14.8	15.2	16.5	15.0	0.34
	2nd	11.9	11.0	10.8	12.3	12.8	12.1	14.8	14.2	14.3	15.5	15.6	15.8	17.2	17.5	16.0	1.10
Seeds /fed Kg)	1st	568	566	568	607	638	633	652	677	672	681	689	684	698	705	702	31.9
	2nd	578	576	588	627	638	632	661	684	682	691	697	698	714	725	733	33.1
Stover /fed(kg)	1st	2025	2035	2041	2134	2184	2154	2187	2197	2192	2210	2230	2212	2264	2287	2276	34.8
	2nd	2035	2045	2048	2156	2192	2197	2205	2197	2194	2250	2260	2271	2294	2297	2286	48.2
Harvest index (%)	1st	21.92	21.78	21.77	22.16	22.61	22.7	22.95	23.56	23.45	23.56	23.62	23.56	23.56	23.87	23.59	0.12
	2nd	21.13	21.99	23.31	22.55	22.54	22.36	23.08	23.74	23.73	23.50	23.58	23.51	23.74	24.0	24.27	0.18
Protein (%)	1st	17.1	17.6	17.4	18.2	18.6	18.3	18.6	18.9	18.7	19.2	18.9	19.4	19.7	19.8	19.6	1.21
	2nd	17.4	17.6	17.8	18.9	18.8	18.8	19.6	19.2	19.1	19.9	19.7	19.5	19.9	19.9	19.8	0.21

***1st season 2015/2016 , 2nd season 2016/2017.**
**** V_3: vegetative stage at 30 days after sowing, R_1: start of flowering at 45 days after sowing and R_6: pod formation at 60 days after sowing)**

CONCLUSION

The recent work shows that the spray of microelements in combined provides a beneficial effect on seed yield of chickpea; zinc was more effective when it was added to chickpea plants with molybdenum and boron. Finally, the pods No./plant is the most effective yield and yield attributes of chickpea.

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تأثير الرش الورقى بمخلوط الزنك و البورون و الموليبدينم عند مراحل نمومختلفة على محصول البذورومكوناته فى الحمص

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تم إجراء عدد ٢ تجربة حقلية لدراسة بهدف دراسة تأثير خمسة معاملات من التسميد الورقى بمخاليط الزنك والبورون و الموليبدنيم على محصول البذور ومكوناته فى الحمص ١ - رش بالماء ٢- رش ورقى بمخلوط الزنك + البورون بمعدل ٠.٥ جم/لتر ٣- رش ورقى بمخلوط الزنك + الموليبدنيم بمعدل ٠.٥ جم /لتر ٤- رش ورقى بمخلوط البورون + الموليبدنيم بمعدل ٠.٥ جم/لتر ٥- الرش الورقى بمخلوط الزنك + البورون + الموليبدنيم بمعدل ٠.٥ جم/لتر و تم تنفيذ الرش عند ثلاثة مراحل نمو هى ١-مرحلة النمو الخضرى (V_3) عند عمر ٣٠ يوم من الزراعة ٢- مرحلة بدء التزهير (R_1) عند عمر ٤٥ يوم من الزراعة ٣- مرحلة بدء تكوين القرون (R_6) عند عمر ٦٠ يوم من الزراعة وتم الحصول على النتائج التالية : تأثرت جميع صفات مكونات المحصول ومحتوى البذور من البروتين فى موسمى الدراسة ,اعطت المعاملة رقم (٥) و الرش بمخلوط الثلاثة عناصر أعلى القيم لصفات طول النبات ٧٢.٢ و ٧٤.٢ سم و عدد الأفرع للنبات ٤.٣٠ و ٤.٣٧ و عدد القرون للنبات ٧٠.٤ و٧٠.٨ و ووزن الـ١٠٠ بذرة ٢٨.٦ و ٢٨.٦ جم و وزن بذور النبات ١٥.٦ و ١٦.٩ جم ومحصول البذور للفدان ٧٠٢ و ٧٢٧ كجم و محصول القش للفدان٢٢٧٥ و ٢٢٧٦ كجم و المحصول البيولوجى للفدان ٢٩٧٧ و٢٩٩٩ جم و دليل الحصاد ٢٦.٦و ٢٤.١% و محتوى البذور من البروتين ١٩.٧ و ١٩.٩% خلال موسمى الدراسة على التوالى. أوضحت النتائج انه ليس هناك أى تأثيرمعنوى لمواعيد الرش عند مراحل النمو المختلفة على جميع صفات المحصول ومكوناته خلال موسمى الدراسة. كما بينت نتائج الدراسة أن تأثير التداخل بين معاملات الرش الورقى و مواعيد الرش عند مراحل النمو المختلفة كان معنويا فى جميع صفات المحصول ومكوناته فى موسمى الدراسة. وكانت أعلى القيم عند المعاملة رقم (٥) وهى الرش بمخلوط العناصر الثلاثة (الزنك و البورون و الموليبدنيم) عند مرحلة بدء التزهير (R_1) عمر ٤٥ يوم من الزراعة. وتوصى الدراسة بزراعة صنف الحمص جيزة ٥٣١ والرش بمخلوط الزنك و البورون و الموليبدنيم بمعدل ٠.٥ جم /لتر عند ٤٥ يوم من الزراعة للحصول على أكبر إنتاجية من البذور و أفضل محتوى بروتين بالبذور..