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Effect of Calcium Humate, Nitrogen Fertilizer Rates and Irrigation Regime on Soil Chemical Properties and Faba Bean Productivity

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ABSTRACT

A field experiment was conducted at Malawi Agric. Res. Station, Minia Governorate, Egypt during two successive winter seasons of 2014/2015 and 2015/2016 to study the effect of calcium humate (Ca-H), as organic soil conditioner, and nitrogen fertilizer rate under irrigation regime on soil chemical properties and faba bean productivity. The experiment was designed in a split plot design with three replicates, the main plots were occupied by three irrigation regimes: Farmer irrigation (I_1), irrigation requirement with 100% WR (I_2) and irrigation 75% WR(I_3) while sub-plots consists of four treatments (control, 100% N(recommended dose) , Ca-Humate (40 Lfed^{-1}) and 75% N + Ca-Humate (40 Lfed^{-1}). Results showed that seasonal water consumptive use increased by increasing available soil moisture as a result of increasing applied water, in general, in both growth seasons. The greatest values of seasonal consumptive use was recorded under farmer practice while the lowest value was recorded under irrigation treatment 75% WR (I_3).Also, the interaction effect between irrigation regime and N rates in combination with Ca-H data show that the highest water use efficiency is 1.00 kg seeds/m^{3}water consumption was obtained by irrigation at 75% WR combined with 75% N+Ca-H at second season. The lowest water use efficiency is 0.30 kg seeds/m^3 water consumption was obtained by control treatment under farmer practice. Results revealed that mean values of different irrigation regimes had significantly increased growth characters of faba bean crop (yield, biological yields, 100 seed, plant height, number of branches, number of pods) were observed with I_2 (100% WR) followed by I_1 (farmer practices) and I_3 (75% WR), respectively. Applied Ca-H individually or in combination with mineral nitrogen fertilizer were significantlyincreased growth characters of faba bean (yield, biological yield, 100 seed, plant height, number of branches, number of pods) as compared to control treatment. The superior treatmentis75%N+Ca-H at 1_2 irrigation levels (100% WR). In addition, data reveal that I_2 irrigation treatment with 75% N+Ca-H was significantly increased macronutrients total content in (straw and seeds), protein content and protein yield in faba bean crop as compared to control treatment at two successive seasons. On the other hand, chemical soil parameters (pH and EC values) were slightly affected with all applied treatments and increased gradually by decreasing irrigation water. The maximum increased was observed with I_2 and applied 75%N+ Ca-H treatment. On the other hand, OM value was decreased with I3 more than I_1 and I_2, as well as, it was increased by applied calcium hamates application.In conclusion, the application of Ca-H in combination with mineral nitrogen fertilizers was enhanced faba bean crop production and increased NPK content, protein content and protein yield along with improved soil chemical properties under irrigation regimes. Also, Ca-H can be saved about 25% from nitrogen fertilizer dose under low amount of irrigation water.

Keywords: irrigation regime, nitrogen rate, calcium humate, soil chemical properties, Faba bean.

INTRODUCTION

In Egypt, Faba bean (*Vicia faba* L.,) is considered one of the strategic crops due to its income to the farmers. Also, it is important for soil fertility, human nutrition as a good source of vegetarian protein animal feeding and industry purposes (Sharaan *et al*., 2004). The major target to meet the demand of the increasing Egyptian population by increasing faba bean production and improving yield quality, since faba bean constitutes a major part of the diet of Egyptian people (Zeidan, 2002).

In arid and semi-arid regions water is limiting natural resources for agricultural production. Nowadays, the total annual water resources of Egypt are about 67.27 billon m^3 (Abo Zied, 2000). The agricultural sector consumes almost 80 - 90 % of the total water allocated to Egypt. The ever increasing of the Egyptian population and the limited water resources led to a steady decrease in per capita share of water. Therefore, Apply irrigation water according to plants need result in more efficient of water resources (Tayel *et al*., 2007).

Moreover, water stress is one of the most significant parameters affecting plant growth, seed quality and photosynthesis productivity for most crops. Ouda *et al*. (2010) reported that 20% of full irrigation supply to faba bean could be saved with approximately yield reduction of 7% .Thus, Alderfasi and Alghamdi (2010) reported that irrigation water with 75% of soil water holding capacity resulted in higher plant height, large number of plant branches, number of pods/plant, 100 seed weight, seed yield/plant and seed yield/ha. Also, Abd El-Hady and Eldardiry (2016) reported that saved water could be used to increased cultivated area. The main purpose of applied deficit irrigation techniques for a specific crop is one or more of the following: i) increasing the productivity of water, generally with adequate harvest quality, ii) allows economic planning and stable income due to a stabilization of the harvest. So, under water deficiency farmers often have to choose among options such as fully irrigating a portion of the field area or deficit-irrigating a larger crop area or changing to crops that require less water, or investing in more efficient irrigation systems (Norwood, 2000), such as longer irrigation intervals, higher moisture depletion, skipping irrigation during the early vegetative growth or during maturation stage, and timing the length of irrigation interval with the stage of plant growth (Faki 1991) this will save irrigation through reducing number of irrigation but still attain similar economic yield. El-Dakroury (2008) added that increasing of the irrigation treatments from 60 to 100% of ETc (Evapotranspiration), significantly increased the growth criteria, i.e. plant height, number of branches, leaves and pods/plant, leaves area and dry weight of both stem and total plant.

Furthermore, crop yield quality and water utilization was depending on irrigation. Bean plants (plant height, biological stover and seed yield) were reduced with decreasing irrigation water rate (Abou-Baker *et al*., 2012). Abdel-Mawgoud (2006) reported that the vegetative growth parameters and yield of faba bean have been increased with increasing the irrigation level from 80 to 120% of class A-pan.

On the other hand, over the last decade, there has been resurgence in the use of humate in agriculture. Humate is natural organic material rich in humic acids

(HA) produced from the biodegradation of dead organic matter, containing carboxyl and phenol so that it behaves functionally as dibasic acid or sometimes as a tribasic acid. Functional groups which most contribute to surface charge and reactivity. The presence of carboxylic groups and phenolic gives the ability to form a complex with humic acid ions such as Mg^{2+}, Ca^{2+}, Fe^{2+}, and Fe^{3+} (Tan, 1998). Cations or metals can be adsorbed by HA through (a) direct adsorption (Ca^{2+} that release PO_4^{3-}), (b) complexation of Cu^{2+} or outer-sphere interactions for hydrated Mg^{2+} , (c) produce a cation bridge through direct or indirect chelation, and (d) interaction with Ca^{2+}-humic acid aggregates or with amine groups (Sharma and Kappler, 2011). Humic materials have a strong affinity to weak acids containing phenolic hydroxyl, a carboxyl group, or amino sulfonyl. Alkaline cations (Na^+, K^+, Ca^{2+}, Mg^{2+}) are primarily retained by simple cation exchange with COOH groups (RCOONa, RCOOK) (Zhang *et al*., 2013). Calcium is added to raise its pH to around 10, and when combined with humate, to provide a source of chelated calcium.

Moreover, Easterwood (2002) found that calcium is a critical part of the cell wall that produces strong structural rigidity by forming cross-links within the pectin polysaccharide matrix. With rapid plant growth, the structural integrity of stems that hold flowers and fruit, as well as the quality of the fruit produced, is strongly coupled to calcium availability. Ca^{+2} is an obligate intercellular messenger coordinating responses numerous developmental cues and environmental challenges (White and Broadley, 2003). The plant needed to Ca during growth stage due to its function as a second messenger in the signal conduction among environmental factors and responses in plant growth and development. Because Ca ions were improved plant growth and nutrient uptake in many ways. It can be indicated most easily by increased leakage of low molecular- weight solutes from cells of Ca deficient tissues in seriously deficient plants, by a general disintegration of membrane structures, and by a loss of cell segmentation, reduced leaf size, necrosis of young leaves, and reduction in fruit quality and yield (Rubio *et al*., 2009 and Shafeek *et al*., 2013).

Yield components, nutrient status and promoted growth of faba bean was improved with foliar application of humic acid (Afifi *et al*., 2010). Also, Knany *et al*. (2009) stated that humic substances alone enhanced faba bean seeds yield by 20.8 & 22.9% in two seasons respectively.

The goal of this study is to evaluate the effect of Ca humate and nitrogen fertilizer rate under different irrigation regime to improve soil chemical properties and increased faba bean yield along with decreasing amount of water requirement.

MATERIALS AND METHODS

A field experiments were conducted at Malawi Agric. Res. Station in El Minya Governorate, Egypt (Latitude, 27° 34' 57.093" N and longitude, 30° 50' 32.819" E) during two winter seasons of 2014/2015 and 2015/2016 to study the effect of organic soil conditioner (calcium humate) and different irrigation regimes on faba bean crop productivity and amelioration chemical properties of the studied soil. Soil characteristics of the used soil are summarized in Table (1) as well as constants of soil moisture and bulk density for the soil depth (0-60 cm) are shown in Table (2).

Meteorological data for Malawi region in both winter seasons 2014/2015 and 2015/2016 growing seasons are shown in Table (3).

Table1. Soil characteristics of the study location

Properties	Value
Sand%	6.02
Silt%	51.52
Clay%	42.46
Soil texture	Silty clay
Organic matter %	1.35
pH (soil-water suspension, 1:2.5)	8.20
EC dSm^{-1} (1:5 soil water extract)	0.40
Soluble cations and anions (meq L^{-1})	
Ca^{++}	1.61
Mg^{++}	0.44
Na^+	1.46
K^+	0.49
CO^-	-
HCO_3^-	1.38
Cl^-	2.20
SO_4^{--}	0.42
Available macronutrients mg Kg^{-1} soil	
N	118.2
P	7.67
K	154

The experiment was arranged in a split plot design with three replicates and the sub- plot area was 42 m^2. The treatments were arranged as followed:

1. Main plots (irrigation regime with three treatments).

A- I_1: Farmer practice.

B-I_2: Irrigation with 100% of water requirement (WR)

C- I_3: Irrigation with 75% of water requirement (WR).

2- Sub-plots (included four treatments).

1. Control (No fertilizer) .
2. 100% N fertilizers (recommended dose).
3. Calcium humate (Ca-H) applied with 40 L fed^{-1}.
4. 75% N + Ca-H

Some chemical properties of Ca-Humate are shown in Table (4) and Fig (1).

Table 2. Soil moisture and bulk density of the experimental site at Malawi Agricultural Research Station

Depth	Field capacity	Wilting point	Available water		Bulk density
Cm	%, w/w	%,w/w	%	mm	g/cm^3
0 – 15	35.68	19.51	16.17	11.06	1.14
15 – 30	33.33	18.2	15.13	18.71	1.18
30 – 45	33.25	18.07	15.18	11.71	1.29
45 – 60	33.18	17.95	15.23	11.97	1.31
Mean	33.86	18.43	15.43	Total 53.49	1.23

Table 3. Meteorological data for Malawi region in 2014/2015 and 2015/2016 seasons

Month	Tmax (°C)	Tmin (°C)	WS (ms^{-1})	RH (%)	SR ($M/J/m^2$/day)
Season 2014/2015					
November	24.0	10.0	3.8	47	15.5
December	19.9	8.0	3.3	55	12.8
January	19.6	3.3	3.8	53	13.8
Febrauary	15.2	7.6	3.8	46	16.0
March	18.9	11.2	4.1	34	16.5
April	28.1	11.0	4.6	28	23.9
Season 2015/2016					
November	25.8	10.8	3.7	51	15.1
December	22.6	6.9	3.8	51	13.6
January	20.4	7.5	3.0	45	14.3
Febrauary	21.7	5.3	4.0	40	17.5
March	26.2	9.2	4.2	39	20.8
April	31.4	14.8	4.1	28	24.0

Table 4.Chemical analysis of calcium humate applied in this study

Parameters	Values
pH	8.40
Organic carbon	0.58
Organic matter (%)	1.00
N (%)	1.40
C\N ratio	0.42
Nutrients (mg L^{-1})	
P	14.6
K	0.90
Na	0.99
Ca	6000
Mg	240
Fe	2.90
Mn	0.10
Zn	-
Cu	0.10

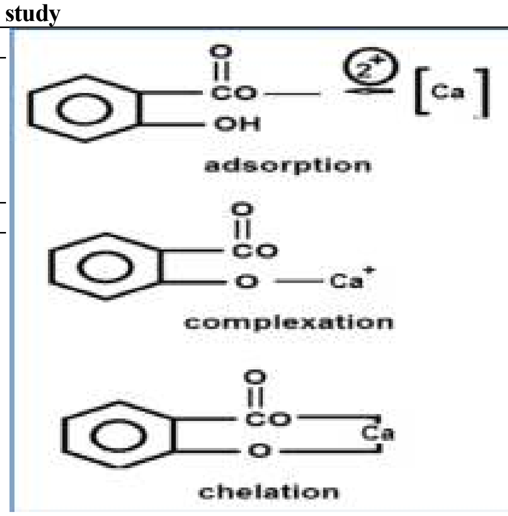

Fig .1. Structure of Ca-humate (Ekinci, 2015)

Faba bean plant with variety (Giza 843) was sowing at 26 November in 2014 and 2015 seasons and irrigation practices were applied during the both seasons of faba bean. Before cultivation phosphate fertilizer at a rate of 200 Kg fed^{-1} was added along with NH_4NO_3 (33 % N) was applied at rate of 15 Kg fed^{-1} before first irrigation. Calcium humate (Ca-H) at rate of (40 L fed^{-1}) was sprayed on soil surface three times every 15 days from sowing. Applied all cultural practices were adopted for growing faba bean crop. At the end of season harvest took place at 8/4/2015 and 10/4/2016 in the first and second seasons, respectively. Ten guarded plants were taken randomly from each sub-plot to evaluate:

1- Plant height (cm).
2- No of seed pod^{-1}
3- Number of branches $plant^{-1}$
4- Number of branches m^2
5- Weight of 100-seed (g).

Also, plants in the central area (4 m^2) of each sub-plot were harvested to determine:

6- Straw yield (Kg fed^{-1}).
7- Seed yield (Kg fed^{-1}).
8- Biological yield (Kg fed^{-1}).

Samples of surface soil (0-25 cm) were taken after harvested to determine of some soil chemical properties according to Cottenie *et al.* (1982). After that, the yield components (straw and seed) of faba bean crop was weighed and oven dried at 70°C until to constant dry weight then grounded and prepared for digestion as described by Page *et al*. (1982). The digests were then subjected to the evaluation of macronutrients (N, P and K according to procedures described by Cottenie *et al.* (1982).

Water relations

1. Water requirement.

Reference evapotranspiration (ET_0) was calculated by CROPWAT model (**version 4.3, Smith *et al*., 1992**). The FAO Penman-Monteith method can be expressed as followed:

$$ETo = \frac{0.408\,\Delta\,(Rn - G) + \gamma \frac{900}{T + 273}\, u2\,(es - ea)}{\Delta + \gamma(1 + 0.34\, u2)}$$

Where:

ETo: reference evapotranspiration (mm day^{-1})
Rn: net radiation at the crop surface (MJ m-2 day^{-1})
G: soil heat flux density (MJ m^{-2} day^{-1})
T: mean daily air temperature at 2m height (°C)
u2: wind speed at 2m height (m s^{-1})
es: saturation vapor pressure (kPa)
ea: actual vapor pressure (kPa)
es-ea: vapor pressure deficit (kPa)
D: slope vapor pressure-temperature curve (KPa°C^{-1})
γ: psychometric constant (kPa°C^{-1})

2. Crop water requirements (CWR)

Water requirements of crop (ETcrop) at two growing seasons were determined from ET_o and estimates of crop evaporation rates, expressed as crop coefficient, (Kc) according to the following equation:

Crop water requirement= (ET crop) = ET_o X Kc

Furthermore, the applied irrigation amounts on the field level in each irrigation were calculated by using cut throat flume.

Irrigation requirement = ((ET_o X Kc) / system application efficiency) + leaching requirement)).

3. Seasonal water consumption use (WCU):

The soil moisture content as a percentage was determined gravimetrically on the oven dry basis before and after 48 hours of each irrigation and at harvesting time. An each sampling date, samples were taken with an auger from different layers each of 15 cm depth from the soil surface and down to 60 cm depth. The amount of water consumed from the root zone area between irrigation was calculated according to Israelsen and Hansen (1962) as follows:

$$WCU, = (\Theta_2 - \Theta_1)/100 \text{ X } (Bd) \text{ X } ERZ$$

Where:

WCU = Water consumption use, (mm/depth)

Θ_2 = Percentage of soil moisture by weight 48 hours after irrigation

Θ_1 = Percentage of soil moisture by weight before the following irrigation

Bd = Bulk density, g cm^{-3} ERZ= Effective root zone, (0.6m).

The seasonal water consumed values was obtained from the sum of water consumptive use for all irrigation per each treatment from planting until harvesting.

4. Water use efficiency (WUE)

Water use efficiency in kg/m^3 water was estimated for each treatment according to the equation described by Vites (1965) as follows:

WUE, kg/m^3 = seed yield (kg fed^{-1})/Seasonal water consumption (m^3 fed^{-1})

All results were statistically analyzed according to Snedecor and Cochran (1980) and treatment means were compared by least significant difference test (LSD) at 0.05% level of significance. The differences between means followed the same alphabetical letter were not statistically significant according to Duncan's multiple range test (Cochran, 1953).

5- Seasonal water productivity

Water productivity values (kg/m^3) were calculated based on Faba bean yield and applied water according to BOS (1980) as follows:

Water productivity (kg/m^3) = Faba bean yield (kg fed.) /applied irrigation water (m^3/ fed.)

RESULTS AND DISCUSSION

Effect of calcium humate and nitrogen rates under irrigation regime on seasonal water relation.

1- Water consumptive use (WCU)

Seasonal water consumptive use (m^3/fed) as affected by irrigation regime and calcium humate combined with nitrogen rates at the first and second seasons of faba bean crop are presented in Table (6). The average values of seasonal water consumptive use irrespective to irrigation regimes and calcium humate in combination with nitrogen rates were 1248 and 1255 m^3/fed. for first and second seasons, respectively. These results showed that water consumptive use by faba bean plants was higher in the second season compared to first season; such results may be due to the differences in climatic factors which affected greatly the seasonal consumptive use.

With respect to effect of irrigation regime on seasonal water consumptive use, data in Table (6) show that mean values of WCU in the first season were 1348, 1316 and 1081 m^3/fed. for irrigation treatments I_1, I_2 and I_3, respectively, while the corresponding values in the second season were 1356, 1321 and 1088 m^3/fed. for the same respective irrigation treatments with faba bean plants. Also, results show that seasonal water consumptive use increased by increasing available soil moisture as a result of increasing applied water, in general, in both growth seasons. The highest values of seasonal consumptive use were recorded under farmer practice while the lowest value was recorded under irrigation treatment 75% WR (I_3).

Table 6. Seasonal applied water, seasonal water productivity , water consumptive use, water use efficiency and water requirement as affected by irrigation regimes and calcium humate in combination with nitrogen rates at two growing seasons of faba bean plant

Irrig. regime	Treat.	SAW		SWP		WCU			WUE		
		1th season	2th season	1th season	2th season	1th season	2th season	Mean	1th season	2th season	Mean
	Cont.					1338	1345	1342	0.30	0.35	0.33
Farmer	100%N					1349	1359	1354	0.70	0.74	0.72
irrig. (I_1)	Ca-H					1343	1351	1347	0.66	0.70	0.68
	75%N+ Ca- H					1361	1368	1365	0.78	0.84	0.81
Mean I1		2264	2284	0.36	0.39	1348	1356	1352	0.61	0.66	0.64
	Cont.					1306	1311	1309	0.37	0.39	0.38
WR	100%N					1328	1331	1330	0.79	0.83	0.81
(I_2)	Ca-H					1310	1316	1313	0.75	0.79	0.77
	75%N+ Ca-H					1318	1324	1321	0.87	0.95	0.91
Mean I_2		2197	2205	0.41	0.44	1316	1321	1319	0.70	0.74	0.72
	Cont.					1076	1081	1079	0.32	0.38	0.35
WR	100%N					1092	1096	1094	0.78	0.91	0.85
(I_3)	Ca-H					1079	1085	1082	0.77	0.88	0.83
	75%N+ Ca-H					1085	1091	1088	0.91	1.00	0.96
Mean I_3		1808	1820	0.42	0.48	1081	1088	1085	0.69	0.80	0.75
	Cont.					1240	1246	1243	0.33	0.37	0.35
Mean of	100%N					1256	1262	1259	0.76	0.65	0.71
treat.	Ca-H					1244	1251	1248	0.73	0.79	0.76
	75%N+ Ca-H					1255	1261	1258	0.82	0.93	0.88
Average all		2090	2103	0.40	0.44	1248	1255	1252	0.67	0.73	0.70

In addition, mean values of seasonal consumptive use under applied treatments in both growth seasons, data in Table (6) show that the maximum average values of WCU were1256 and 1262 m^3/fed. when applied recommended dose of nitrogen (100% N) in the two growing seasons, respectively, while, the minimum values were 1240 and 1246 m^3/fed. at control treatment for the same respective season. Application of 75% N+Ca-H was recorded nearly the maximum seasonal water consumptive use but it saved in nitrogen dose by 25%.

Concerning the Interaction effect between irrigation regime and calcium humate in combination with nitrogen rates, results in Table (6) show that the highest value of water consumptive use (1361 and 1368 m^3/fed. in the first and second seasons, respectively, were obtained under farmer practice combined with 75% N+ Ca-H. On the other hand, the lowest value 1076 and 1081 m^3/fed. were obtained for the control treatment under irrigation regime with I_3 (75% ET_0). Obtained results are in harmony with those obtained by EL-Dakroury (2008).

2- Water use efficiency (WUC)

Regarding to the effect of irrigation regimes on the average of water use efficiency (WUE) by faba bean crop, values were 0.61, 0.70 and 0.69 kg seed/m^3 in the first season and 0.66, 0.74 and 0.80 kg seed/m^3 in the second season were obtained when irrigated faba bean plants with I_1, I_2 and I_3, respectively. The highest value (0.70 kg seed/m^3) was obtained when faba bean plants irrigated with 100% WR in the first season as well as (0.80 kg seed/m^3) at75% WR in the second season. Also, the lowest value of WUE was obtained when plants irrigated with farmer practice (I_1).It may be worth to mention that the values of WUE were lower in the first season compared to the second season. These results may be attributed to lower seeds yield in the first season compared to the second season. Such results are in harmony with those reported by Alderfasi and Alghamdi (2010).

Moreover, results presented in Table (6) indicated that applied Ca-H in combination with N rates effect WUE of Faba bean plants. Average values of WUE were 0.33, 0.76, 0.73 and 0.82 Kg seeds/m^3 water consumption in the first season as well as 0.37, 0.65, 0.79 and 0.93 Kg seeds/m^3 in the second season. The highest values were 0.82 and 0.93 Kg seeds/m^3 water consumption in the first and second season, respectively, obtained when faba bean plants treated with 75% N+Ca-H. The lowest values of WUE were 0.33 and 0.37 Kg seeds/m^3 water consumption was obtained at control treatment.

Results show that WUE was increased due to adding calcium humate, these due to the enhancement of water stored in the effective root zone and these observations indicated that addition calcium humate fertilizer mitigated the harmful effect of water stress, because the trudged cells of the stomata closed most of time, so transpiration rate decreased, however there is no need for more water to be absorbed by plant roots which in turn reduce the amount of absorbed water. Similar results were obtained by Shafeek *et al*. (2013).

With respect to, the interaction effect between irrigation regime and N rates in combination with Ca-H data in Table (6) show that the highest water use efficiency was 1.00 Kg seeds/m^3 water consumption was obtained by irrigation at 75% WR combined with 75% N+Ca-H at second season. The lowest water use efficiency 0.30 Kg seeds/m^3 water consumption was obtained by at control treatment under farmer practice in first season.

3- Seasonal water productivity (SWA)

Data presented in Table (6) indicated that irrigation regime (I_3) at 75% WR gave the maximum value of water productivity, namely 0.42 and 0.48 kg/m^3 in two seasons, respectively. This result may be due to lower seasonal applied water and higher faba bean seed yield under irrigation at 75% WR. Whereas, the minimum values of water productivity were 0.36 and 0.39 kg/m^3 under farmer practice (I_1) in the first and second seasons, respectively. These results are in line with those reported by Siam *et al*. (2017) who observed that faba bean plants irrigated by 75% of the ET_0 gives the highest values of WP for grain and straw yield . Also Eldardiry *et al*. (2016) concluded that, WP values at 75 % of ET_o irrigation treatment was higher than control of faba bean plant. In addition, irrigation at 75 % from WR had a superior effect on faba bean yield .Along with the application organic amendment was improved the yield and WP by 5.1 and 5.0 %, respectively, as compared with control.

4-Seasonal applied water (SAW)

Seasonal water applied (SAW) was affected by irrigation regimes and calcium humate in combination with nitrogen rates as shown in Table (6). With respect to irrigation regimes, SAW values in the first season were 2264, 2197 and 1808 m^3/fed. for I_1, I_2, and I_3 irrigation treatment respectively. The same respective values in the second season were 2284, 2205 and 1820 m^3/fed. These results show that water applied increased as available soil moisture increased in the root zone of plants. While, faba bean plants subjected to soil water deficit caused decrease in SAW. The results indicated that the average of water applied was high in the second season compared with the first season, due to high temperature. This higher temperature would automatically result in higher consumptive use and consequently increased SAW.

Effect of calcium humate and nitrogen rates under irrigation regime on growth parameters of faba bean.

1- Growth parameters and yield components of faba bean.

Data in Table (7&8) show that mean values of different irrigation regime and their effect on faba bean yield and its components i.e. (straw and seeds yield, biological yield, weight of 100 seeds, plant height, number of seeds/pod , number of branches/plant, number of branches/m^2) at two growth seasons. Generally, results indicated that significant increase in growth characters of faba bean plant was observed with I_2 (100% WR) followed by I_1 (farmer practices) and I_3 (75% WR), respectively.

Similar results were obtained with El- Dakroury (2008) who found that increasing irrigation treatment from 60 to 100% of the ET_0 significantly increased faba bean growth criteria i. e. number of branches, plant height, leaves and pods / plant, leaves area, and dry weight of both stem and total plant. Tayel and Sabreen(2011) added that the decreasing of faba bean growth characters in the presence of irrigation shortage water may be due to water stress, which decreased plant photosynthesis, subsequently growth characters, ,decreased nodules numbers which are the active sites for gaseous N fixation symbiotically, leaves wilting and pores closing and leaves and flowers abscission. Hegab *et al*. (2014) concluded that the biological and seed yields of faba bean followed by 0.80 irrigation rate (IR) were increased significantly during the two tested seasons. Low irrigation level (0.6 IR) sharply decreased biological and seed yields in the first season by 31.6% and 15.3%, respectively, and second season by 11.8% and 19.7%,

Table 7. Growth parameters and yield components of faba bean crop at first season as affected by calcium humate , nitrogen fertilizer and irrigation regime treatments

Irrig. regime	Treat.	Straw Kg fed^{-1}	Seed Kg fed^{-1}	Biological yield Kg fed-1	Weight of 100 seed (g)	Plant height (cm.)	No of seed pod^{-1}	No of branches plant -1	No of branches / m2
	Cont.	795	395	1190	68.1	95.3	3	10	65.7
Farmer	100%N	1992	841	2933	73.6	100.3	3	13	69.0
irrig. (I_1)	Ca-H	1914	886	2800	69.4	95.7	3	12	67.3
	75%N+ Ca-H	2230	1055	3286	75.5	105.7	3	15	71.0
Mean I_1		1733	819	2552	72.0	99.0	3	13	68.0
	Cont.	1015	485	1500	69.4	94.3	3	13	70.3
100%WR	100%N	2180	1051	3230	74.9	105.7	4	14	70.0
(I_2)	Ca-H	2016	985	3000	70.7	97.7	3	14	71.3
	75%N+ Ca-H	2445	1149	3595	77.0	112.3	4	15	76.0
Mean I_2		1914	918	2831	73.0	103	3	14	72.0
	Cont.	726	340	1066	64.5	85.3	3	10	60.7
75%WR	100%N	1807	855	2662	70.2	95.3	3	11	63.7
(I_3)	Ca-H	1631	832	2464	66.4	92.7	3	10	61.3
	75%N+ Ca-H	2033	978	3012	71.6	100.7	3	12	71.3
Mean I_3		1549	751	2301	68.0	94.0	3	11	64.0
	Cont.	845	407	1252	67.0	92.0	3	11	66.0
Mean of	100%N	1993	949	2942	73.0	100	3	13	68.0
treat.	Ca-H	1854	901	2755	69.0	95.0	3	12	67.0
	75%N+ Ca-H	2236	1061	3297	75.0	106		14	73.0
LSD at 0.05%									
A (irrigation)		44.76	10.39	44.08	2.59	4.97		0.44	5.20
B (treatment)		62.7	14.07	87.20	1.55	3.93	NS	0.73	3.94
A*B		108.6	24.4	108.5	2.69	6.80		1.26	6.82

Table 8. Growth parameters and yield components of faba bean crop at second season as affected by calcium humate , nitrogen fertilizer and irrigation regime treatments

Irrig. regime	Treat.	Straw Kg fed^{-1}	Seed Kg fed^{-1}	Biological yield Kg fed^{-1}	Weight of 100 seed (g)	Plant height (cm.)	No of seed pod-1	No of branches plant -1	No of branches / m2
	Cont.	1014	466	1480	68.6	105.0	3	11	65.0
Farmer	100%N	2040	1005	3045	74.1	111.7	4	14	71.3
irrig. (I_1)	Ca-H	1920	950	2870	69.3	108.3	3	12	71.3
	75%N+ Ca-H	2316	1150	3467	75.9	112.3	4	16	72.0
Mean I_1		1823	893	2716	72	109	4	13	70.0
100%	Cont.	1112	507	1620	70.2	110.3	3	15	69.0
WR	100%N	2420	1100	3520	74.7	114.7	4	15	75.0
(I_2)	Ca-H	2300	1046	3346	73.4	112.7	3	15	72.0
	75%N+ Ca-H	2645	1252	3898	77.4	116.3	4	17	77.3
Mean I_2		2120	976	3096	74	114	4	16	72.0
	Cont.	828	408	1236	67.3	88.0	3	10	62.3
75% WR	100%N	1828	1002	2830	71.8	98.3	3	11	67.7
(I_3)	Ca-H	1795	951	2746	68.0	95.3	3	11	64.3
	75%N+ Ca-H	2126	1100	3226	73.0	101.3	3	13	70.0
Mean I_3		1644	865	2509	70	96.0	3	11	66.0
	Cont.	985	460	1445	69	101	3	12	65.0
Mean of	100%N	2096	1036	3132	74	108	4	14	71.0
treat.	Ca-H	2005	982	2987	70	105	3	13	69.0
	75%N+ Ca-H	2362	1168	3530	75	110	4	15	73.0
LSD at 0.05%									
A (irrigation)		163.3	36.31	42.46	1.28	5.48		0.44	3.93
B (treatment)		170.0	26.82	196.10	1.04	4.73	NS	0.67	3.68
A*B		294.0	46.46	284.9	1.79	8.19		1.17	6.38

respectively, than optimum irrigation (1.00 IR). Such increase can be explained by Erdem *et al*. (2006) who stated that adequate moisture availability in soil leads to increase various physiological processes, better of nutrients uptake, higher rates of photosynthesis which might reflected on more number and area of leaves and higher yields.

Data presented in Table (7&8) show that applied nitrogen fertilizer and Ca-H were generally increased significantly growth characters of faba bean as compared to control treatment. The superior treatment was (75%N+Ca-H) followed by applied recommended dose of nitrogen (100% N).This increase in yield and yield components in this study may be due to the role of humic materials in stimulates root growth and affects root morphology by organic acid exudation, which in turn leads to increased nutrient uptake and thereby improves the growth and yield of crops (Canellas *et al*., 2008). Also, Atiyeh *et al*. (2002) and Nardi *et al*. (2002) reported that humic materials with auxin-like activities could promote cell elongation, apical dominance, and rooting, resulting in high crop yield. The hormone-like activity of humic materials, which is indicated as concentration-specific (Zandonadi *et al*., 2007), and increases in cell permeability to improved absorption of mineral nutrients (Dursun *et al*., 2002 and Zandonadi *et al*., 2007) could be responsible for humic materials have the stimulatory effect on plant yield and quality. Furthermore, humic materials can be formed a complexed compound when attach with mineral ions, the catalysis of humic materials by the enzymes in the plant, the influence of humic materials on respiration and photosynthesis, the stimulation of nucleic acid metabolism, and the hormone another possible factor might be Ca, which along with cell division and cell elongation is also involved in cell membrane stability and permeability, thus strengthening the plants (Ashraf, 2004 and Hirschi, 2004). Calcium deficiency lead to reduced leaf size, necrosis of young leaves, and reduction in fruit quality and yield (Hao and Papadopoulos, 2003). Plant length, dry matter yield, leaf area, fruit fresh weight, number of fruits, fruit diameter, total yields, and marketable fruit yields were increased with increasing Ca^{2+} concentration in the nutrient solution (Rubio *et al*., 2009 and Shafeek *et al*., 2013).

The interaction effect between irrigation regime and tested treatments revealed that applied irrigation I_2 (100% WR) and 75%N+ Ca-H was superior treatment for faba bean growth parameters as compared to either treatment or control at both growth seasons. Also data of all faba bean yield components in second season was superior as compared to first season. Our results are in accordance with the findings of Celik *et al*. (2008) and Karakurt *et al*. (2009) that documented the application of Ca and HA were significantly increased growth and yield.

2- Total content of macronutrients

Data presented in Table (9) show the effect of irrigation regime and calcium humate in combination with nitrogen rates on macronutrients total content by both straw and seeds of faba bean plant at two successive season. Mean value of different irrigation treatments revealed that applied I_2 (100 WR) was generally increased N, P and K total content of faba bean plants (straw and seeds) as compared to either I_1 (farmer practice) or I_3 (75% WR). Moreover, applied I_3 (75% WR) give the lower values of N, P and K uptake of faba bean straw and seed as compared to 100% WR irrigation treatment. Such reduction in N, P and K reaches to 17.8, 16.5 and 23.6% for straw while these reduced reached to 12.7, 8.81 and 11.3% in seed, respectively, at first season. Similar trend was observed in the second season.

Table 9. Macronutrients total content of Faba bean crop, at both two seasons, as affected by calcium humate , nitrogen fertilizer and irrigation regime treatments

Irrig. Regime	Treat.	First season						Second season					
		Straw (Kg fed^{-1})			Seed (Kg fed^{-1})			Straw (Kg fed^{-1})			Seed (Kg fed^{-1})		
		N	P	K	N	P	K	N	P	K	N	P	K
Farmer irrig. (I_1)	Cont.	10.82	3.16	15.4	12.30	2.70	5.13	8.73	3.24	8.63	13.7	3.58	4.00
	100%N	23.16	9.52	38.0	33.36	7.79	11.8	22.26	9.41	19.5	31.9	7.93	9.32
	Ca-H	21.32	6.62	32.7	29.63	6.55	11.0	19.13	7.79	24.4	29.2	5.81	11.2
	75%N+ Ca-H	31.22	13.98	38.9	40.55	9.24	12.7	26.62	14.38	30.3	36.6	7.65	12.9
Mean I_1		21.63	8.32	31.2	28.96	6.57	10.2	19.19	8.71	20.7	27.84	6.24	9.3
100%ET_0 (I_2)	Cont.	11.32	3.23	16.0	15.63	3.09	6.11	11.76	5.61	13.8	13.6	5.10	6.49
	100%N	25.45	8.98	38.4	36.45	9.22	13.7	27.12	11.85	25.7	35.3	9.38	16.8
	Ca-H	22.88	6.45	34.1	32.93	6.87	13.0	25.42	11.97	27.5	32.7	7.21	13.8
	75%N+ Ca-H	29.71	18.40	40.6	40.94	10.30	14.3	29.62	14.46	35.3	40.7	8.04	15.9
Mean I_2		22.34	9.26	32.3	31.49	7.37	11.8	23.48	10.97	25.6	30.6	7.43	13.2
75%ET_0 (I_3)	Cont.	8.09	2.69	12.0	11.06	2.73	4.36	8.19	3.95	9.24	12.7	3.43	5.28
	100%N	20.52	9.02	27.8	31.51	7.88	11.2	21.62	10.75	22.3	34.2	6.55	11.2
	Ca-H	20.10	7.29	28.4	30.56	6.79	10.9	17.33	8.82	25.5	30.5	7.14	9.2
	75%N+ Ca-H	24.82	11.92	32.0	36.83	9.49	12.5	24.39	14.26	25.2	39.8	8.04	12.7
Mean I_3		18.38	7.73	25.1	27.49	6.72	9.8	17.88	9.44	20.5	29.28	6.29	9.6
ConditionerMean	Cont.	10.08	3.02	14.5	13.00	2.84	5.2	9.56	4.27	10.6	13.32	4.04	5.3
	100%N	23.05	9.17	34.8	33.77	8.30	12.2	23.67	10.67	22.5	33.79	7.95	12.4
	Ca-H	21.43	6.79	31.7	31.04	6.74	11.6	20.63	9.53	25.8	30.78	6.72	11.4
	75%N+ Ca-H	28.59	14.77	37.2	39.44	9.68	13.2	26.88	14.36	30.3	39.04	7.91	13.8
LSD at 0.05%:-													
A (irrigation)		1.942	2.62	5.3	1.31	2.49	0.51	3.01	3.94	5.88	1.45	1.77	3.92
B (treatment)		1.61	4.58	12.4	2.39	1.46	0.585	2.89	2.15	6.78	4.73	1.23	4.53
A*B		2.79	7.92	11.4	4.13	2.54	1.01	5.01	3.72	11.73	8.19	2.14	7.84

Obtained results were agreement with Siam *et al.* (2017) who reported that NPK content in straw of faba bean was increased significantly by increasing the availability of soil moisture regime especially under the 100% ETc treatment. The different increase content among irrigation regimes was significant at the 5%, level. This may be attributed to 1) water stress decreased plant photosynthesis and subsequently growth characters, (2) water stress decreased nodules numbers which are the sites for gaseous N fixation symbiotically, (3) leaves wilting and pores closing and (4) leaves and flowers abscission. This concluded that irrigation with 100% of field capacity was most preferable for their faba bean plant.

According to the effect of applied treatment, mean values of obtained data indicated that the application of recommended dose of N fertilizer or 75% N + Ca-humate in combination were significantly increased macronutrients total content in both straw and seed of faba bean plant as compared to control treatment at two successive seasons. Also, can concluded that the application of Ca-humate to soil cultivated with faba bean crops can be compensate about 25% from recommended N fertilizer and keep the same increasing in amount of macronutrients uptake.

The interaction effect between irrigation regime and different treatments (Table 9) revealed that the macronutrients total content in both straw and seed of faba bean crop was significantly affected with all applied treatments especially under irrigation regime I_2 (100% WR) and used 75% N+Ca-H treatment . Such results are in harmony with Mohamed and Ebead (2013) who stated that applied calcium phosphate as a source of Ca fertilizer in combination with organic amendment resulting in an increase in the NPK content in shoots and leaves of bean plants.

3- Protein content and protein yield.

Data in Table (10) represented the protein percentage and protein yield at two growing seasons of faba bean crop. Obtained results reveal that all applied treatments were increased both protein content and protein yield of faba bean seeds as compared to control treatment.

With respect to the effect of irrigation treatments, mean values showed increased in protein content and protein yield with reduced irrigation water amount. The more reduced values gained with I_1 than I_2 and I_3. Obtained data agreement with Hegab *et al*.(2014) who reported increasing irrigation level up to 1.00 IR lead to gradually decreased carbohydrate and protein percent. While, the lowest carbohydrate and protein percent were given by 1.00 irrigation level treatments during the two studied seasons. Such increase may be due to water stress as in adequate water supply caused hydrolysis and catabolism in proteins and released free amino acids and ammonia as well as proline. In addition, El-Ghobashy and Youssef (2002) reported that at severe water stress (75% depletion) faba bean gave the highest protein percentage. Similar results were obtained by Alderfasi and Alghamdi (2010) who added that under severe, moderate and normal irrigations faba bean seed protein content improved through water stress treatment. Musallam *et al*. (2004) found that highly water deficit increased seed protein compared with low ones. Siam *et al*. (2017) found that there is an increasing trend in protein content of faba bean seed with less supply of water i.e. seed protein of 75% ETc water regime had more protein content than 100% ETc water treatment.

Furthermore, data also showed that applied 75% N+ Ca-H treatment was superior of both protein % and protein yield as compared either control or other treatments under all tested irrigation regime at two studied seasons. In this respect Fouda *et al*. (2017)studied the effect of mineral fertilizers, and organic materials on protein % in faba bean seeds and found that applied NPK + organic materials treatment increased protein % in seeds compared to other treatments and/ or control in cultivation season. Also, Russel (2008) who mention that bacterial growth can be supplement with carbohydrate during bean plant cultivated so, the bacteria fix atmospheric N_2 into NH_4^+ in the soil, to be converted into amino acids to synthesize proteins by the plant for its growth and development.

Table 10. Protein content (%) and protein yield in faba bean seedsat both two seasons, as affected by calcium humate , nitrogen fertilizer and irrigation regime treatments

Irrig. regime	Treat.	1st season Protein %	1st season Protein Yield kg fed-^{1}	2nd season Protein %	2nd season Protein Yield kg fed-^{1}
	Cont.	20.1	69.2	18.5	86.0
Farmer	100%N	21.7	196.9	19.8	198.9
irrig. (I_1)	Ca-H	20.9	191.0	19.2	182.5
	75%N+ Ca-H	22.3	230.2	19.9	228.7
Mean I_1		21.3	171.8	19.3	174.0
	Cont.	20.3	76.9	19.8	79.0
100%WR	100%N	23.0	209	21.5	213.8
(I_2)	Ca-H	22.9	185	20.3	190.4
	75%N+ Ca-H	23.5	253	22.0	248.6
Mean I_2		22.5	181	20.9	183.0
	Cont.	19.4	97.7	19.3	85.3
75%WR	100%N	22.2	227.8	21.3	220.2
(I_3)	Ca-H	20.9	205.8	20.0	203.8
	75%N+ Ca-H	21.0	255.9	22.6	254.5
Mean I_3		21.9	196.8	20.8	191.0

Effect of calcium humate and nitrogen rates under irrigation regime on soil chemical properties after faba bean harvested.

1- Electrical conductivity (EC)

Results in Table (11) show the effect of irrigation regime and studied treatments on EC values of soil after two growing season of faba bean crop. Generally, mean values of EC were increased by decreasing the amount of water applied; the maximum increase was observed with I_3 (75% WR) compared to I_1 and I_2.

Furthermore, the presented data in Table (11) revealed that the application of Ca-H with or without nitrogen fertilizers were generally increased mean values of soil EC as compared to control treatment. The interaction between irrigation regime and different treatments observed that high soil EC value was obtained with Ca-H application especially at I_3; such increase may be due to concentrated of salt under shortage of water amount. Also, the presence of humic materials were increased the effect of high salt in clay soil. Obtained data agreement with Eldardiry *et al*. (2012) who concluded that application HA_1(1g l^{-1}) and HA_2 (2g l^{-1}) led to increase soil EC by about 51 and 74 % above the untreated plot, respectively. Also, this finding could attribute to ability of HA to retain more nutrients and keep it from leaching (Rajpar *et al*., 2011).

2- Soil reaction (pH)

The availability of macronutrients element in soil was correlated with pH values which consider the more important factor to explain the vitality of soil and activate. Data presented in Table (11) showed that the effect of irrigation regime, Ca –H and nitrogen rate on soil pH after faba bean harvested at two successive seasons. Obtained results clear that slightly variables were obtained between all means of irrigation treatments. Mean value of pH under I_2 (100% WR) was increased as compared to other irrigation treatments. Such results confirmed by Eldardiry *et al*. (2012) who found that pH data could be arranged in descending order as follows: 100% > 75% > 50% from irrigation levels.

Concerning the effect of treatments, observed mean values of pH also slightly increased in all treatments as compared to control treatment. Applied 75% N + Ca-H was relatively increased in pH value compared to other treatment; this result was true for both studied seasons. obtained result was agreement with Eldardiry *et al*. (2012) who reported that applied humic material changed soil pH by about 0.37 and 0.49 % for HA1 (1g l^{-1})and HA2 (2g l^{-1}) comparing with control one, respectively.

The interaction between irrigation regimes and studied treatment revealed that under irrigation treatment I_2 (100% WR), pH values were relatively high as compared to other irrigation regime for all treatments especially 75% N+Ca-H due to the humic material did not have a strong buffer capacity to base additions. Also humic acid as organic materials resisted pH change in the range between pH 5.5 and 8.0 along with humic acids contain chemical reactive functional groups, such as carboxyl as well as phenolic and alcoholic hydroxyls that have pH dependent change properties. Also, Ouatmane *et al*. (1999) who found that Ca- H complex formation at different pH slightly acid, neutral and basic pH.

Table 11. Soil chemical properties, at both two seasons, after faba bean crop harvested as affected by calcium humate, nitrogen fertilizer and irrigation regime treatments

Irrig. regime	Treat.	First season			Second season		
		EC (dS m^{-1})	pH (1.2.5)	OM %	EC (dS m^{-1})	pH (1.2.5)	OM %
	Cont.	0.148	7.57	1.35	0.116	7.94	1.60
Farmer	100%N	0.158	7.85	1.42	0.167	7.78	1.62
irrig. (I_1)	Ca-H	0.160	7.92	2.14	0.170	7.93	1.70
	75%N+ Ca-H	0.162	7.93	2.19	0.193	8.08	1.96
Mean I_1		0.157	7.82	1.77	0.162	7.90	1.68
	Cont.	0.156	7.96	1.28	0.130	8.05	1.10
100%WR	100%N	0.160	8.00	1.50	0.168	7.90	1.40
(I_2)	Ca-H	0.163	8.05	1.60	0.225	7.98	1.73
	75%N+ Ca-H	0.164	8.10	1.68	0.263	8.01	1.83
Mean I_2		0.161	8.03	1.52	0.204	8.00	1.52
	Cont.	0.160	7.96	1.01	0.121	7.93	1.08
75%WR	100%N	0.163	7.96	1.38	0.173	7.93	1.13
(I_3)	Ca-H	0.171	8.00	1.58	0.211	7.87	1.17
	75%N+ Ca-H	0.172	7.99	1.72	0.403	7.98	1.35
Mean I_3		0.167	7.98	1.42	0.218	7.90	1.18
	Cont.	0.15	7.83	1.21	0.12	7.97	1.26
Mean	100%N	0.16	7.94	1.43	0.17	7.87	1.38
of treat.	Ca-H	0.16	7.99	1.77	0.20	7.93	1.53
	75%N+ Ca-H	0.17	8.01	1.86	0.29	8.02	1.71

3- Organic matter (OM)

With respect to the effect of different irrigation regime system data in Table (11) indicated that by increasing water stress mean values of organic matter content decreased gradually by decreased irrigation water amount which applied to faba bean crop for both seasons. The marked reduction in OM was observed with I_3 compared to I_1or I_2. Also, organic matter was enhancement by added Ca-H alone or when applied in combination with 75% N as compared to control; such increased was markedly with 75%N +Ca-H. This trend was observed in both seasons. Obtained data agreement with Wuddivira and Camps-Roach(2007) who found that the organic matter probably not having had sufficient time to react with the clay in the soils. It is worth noting therefore that addition of Ca^2 with organic matter will create temporary disaggregation in soils. Care should be taken, then, in bringing these soils immediately under cultivation after treating the soil with Ca^2 or organic amendments or both, but awaiting long-term improvement of aggregation through the Ca^2 bridging effect, and stabilization.

4. Available macronutrients in soil

The nutrients status in soil is important factor to enhancement soil fertility and nutrient content in plant. The presented data in Table (12) show the effect of irrigation regime system in combination with Ca-H and N fertilizer rate on available macronutrient in soil.

Obtained data reveal that there is positive relationship between soil available N, P& K and the amount of water received. Generally, mean values of available N, P and K were increased in both I_1 and I_2 then to be decreased toward I_3 for two studied seasons. It may be worth to mention that the mean values of available N, P and K were high in first season as compared to second season.

Moreover, mean values of applied treatment on N , P and K availability observed that ,in general, applied treatments have positive effect on macronutrients availability as compared to control treatment; high value was recorded when applied 100% mineral nitrogen. Obtained data are agreement with Fouda *et al*. (2017).

On the other hand, the interaction effect between irrigation regime and all treatment show that N fertilizer individually or in combination with Ca-H was generally increased the available and N, P and K in soil as compared to control treatment at two successive seasons. Also, applied Ca-H individually or in combination with nitrogen was superior treatment under irrigation treatment I_2 (75% WR) especially at first season. This phenomenon may be due to the application humic materials led to increased N and P availability in soil and enhanced plant root to absorb more amounts from these elements which expected to increased N and P uptake by plant and decreased N and P availability in soil at the end of season. Vanlauwe *et al.* (2000) reported that P able to liberate during N2 fixation, converting it into available forms in the soil as well as incorporating it as biomass with organic amendments application. Suhane (2007) added that organic amendments give higher available N in soil to plants more than nitrogen fertilizers applied at 100 kg to soil because only 20-25 kg N is available. Singh and Chauhan (2009) who found that continued application of compost (organic nitrogen) potassium is more effective than chemical fertilizer; it tends to be released at a constant rate from the accumulated humus.

Table 12. Available macronutrients, at both two studied seasons, after faba bean crop harvested as affected by calcium humate , nitrogen fertilizer and irrigation regime treatments.

Irrig. regime	Treat.	First season			Second season		
		N (mg Kg^{-1})	P (mg Kg^{-1})	K (mg Kg^{-1})	N (mg Kg^{-1})	P (mg Kg^{-1})	K (mg Kg^{-1})
Farmer irrig. (I_1)	Cont.	175	20.4	109	175	10.4	123
	100%N	280	32.0	248	189	11.3	226
	Ca-H	254	25.9	255	175	9.90	254
	75%N+ Ca-H	198	25.0	240	175	7.00	232
Mean I_1		227	25.7	213	179	9.65	209
100%WR (I_2)	Cont.	244	24.1	103	168	7.70	123
	100%N	431	27.5	265	196	12.6	296
	Ca-H	263	27.0	302	175	11.0	281
	75%N+ Ca-H	263	25.5	260	175	10.5	160
Mean I_2		300	26.0	232	179	10.5	215
75%WR (I_3)	Cont.	201	24.2	164	175	6.90	172
	100%N	271	26.7	220	189	9.70	218
	Ca-H	260	26.5	255	175	7.00	232
	75%N+ Ca-H	236	24.3	248	154	7.80	226
Mean I_3		242	25.4	222	173	7.90	212
Mean of treat.	Cont.	207	22.9	125	173	8.33	139
	100%N	327	28.7	244	191	11.20	247
	Ca-H	259	26.5	271	175	9.30	256
	75%N+ Ca-H	232	24.9	249	168	8.43	206

CONCLUSION

From the previous results can be summaries that, the using of calcium humate as organic soil conditioner with different rate of nitrogen applied under water shortage led to increasing SWC, WUE, faba bean yield, NPK total content and protein yield. Additionally, improving soil productivity by increasing OM and available NPK soil content; whereas soil pH and EC were no statically affected with all treatments applied. Moreover under water stress the application of Ca-H can be saved about 25% from recommended dose of nitrogen fertilizer.

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تأثير هيومات الكالسيوم ومعدلات التسميد النتروجيني وتنظيم الرى على خواص التربة الكيميائية وانتاجية الفول البلدى

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اجريت تجربتان حقليتان بمحطة البحوث الزراعية بملوي- محافظة المنيا خلال موسمي ٢٠١٤/ ٢٠١٥ و ٢٠١٥/ ٢٠١٦ لدراسة تأثير هيومات الكالسيوم (Ca-H)كمصلح للتربة ومعدلات تسميد ازوتي تحت معاملات ري مختلفة علي انتاجية محصول الفول البلدي والعلاقات المائية وتأثير ذلك علي خواص التربة وقد استخدم التصميم الاحصائي لقطع منشقة مع ثلاث مكررات حيث شغلت معاملات الري القطع الرئيسية (ممارسات المزارع I_1– الري عند ١٠٠% من الاحتياجات المائية I_2- الري عند ٧٥% من الاحتياجات المائية) وشغلت القطع المنشقة معاملات الكنترول (بدون تسميد)- ١٠٠% نيتروجين + هيومات كالسيوم- ٧٥% نيتروجين + هيومات كالسيوم. وقد اظهرت النتائج الاتي: زاد الاستهلاك المائي الموسمي بزيادة الرطوبة الميسرة بالتربة في كلا الموسمين نتيجة لزيادة الماء المضاف. سجلت اعلي قيمة لكفاءة استخدام الماء تحت معاملة ممارسات المزارع بينما اقل القيم سجلت تحت معاملة الري I_3 . اظهر التفاعل بين معاملات الري ومعدلات النيتروجين مع هيومات الكالسيوم اعلي قيمة لكفاءة استخدام ال (اكجم بذور/ م^3 مياه) سجلت عند معاملة الري ٧٥% من الاحتياجات المائية مع معملة ٧٥% نيتروجين+هيومات الكالسيوم في الموسم الثاني بينما اقل القيم كانت (٠.٣ كجم بذور/م^3 مياه)عند معاملة الكنترول(ري المزارع) متوسط قيم معاملات الريالمختلفة كان لها تأثير معنوي حيث زادت صفات النمو والمحصول للفول البلدي حيث زاد كل من المحصول البيولوجي – وزن ١٠٠ بذرة- طول النبات- عدد الفروع- عدد القرون وذلك عند معاملة الري ١٠٠% من الاحتياجات المائية يتبعها معاملة ري المزارع ثم معاملة ٧٥% من الاحتياجات المائية علي التوالي. ادي اضافة هيومات الكالسيوم منفردا او مع الخلط بالأسمدة النيتروجينية الي زيادة معنوية للمحصول وصفات النمومقارنة بمعاملة الكنترول وكانت افضل معاملة للاضافة هي ٧٥%+هيومات الكالسيوم تحت تأثير ١٠٠% من الاحتياجات المائية. أظهرت النتائج ان معاملة الري ١٠٠% من الاحتياجات المائية مع ٧٥% نيتروجين+ هيومات الكالسيوم زيادة معنوية في المحتوي الكلي للعناصر الكبري في محصول القش والبذور ومحتوي البروتين بالبذور مقارنة بعاملة الكنترول في كل من الموسمين. تأثرت قيم الاس الهيدروجيني والتوصيل الكهربائي للتربة بشكل طفيف مع جميع المعاملات التي تم تطبيقها وزادت تدريجيا بانخفاض كمية مياه الري واضافة محسنات التربة وسجلتاعلي زيادة مع معاملة الري ١٠٠% من الاحتياجات المائية مع ٧٥% نيتروجين+هيومات كالسيوم. انخفضت قيمة المادة العضوية مع معاملة الري ٧٥% من الاحتياجات المائية وزادات بمعاملة هيومات الكالسيوم. مما سبق يمكن القول بأن اضافة هيومات الكالسيوم بالخلط مع الاسمدة النيتروجينية المعدنية قد حسنت انتاج محصول الفول البلدي وادت الي تحسين محتوي N,P,K والبروتين مع تحسين خواص التربة الكيميائية تحت معاملات الري. كما ان استخدام هيومات الكالسيوم ادي الي توفير ٢٥% من التسميد النيتروجيني المستخدم تحت معدلات الري المنخفضة.