Effect water stress and levels of phosphate fertilizer on forage quality traits of Sorghum (*Sorghum bicolor* (L.) Moench) cultivars.

Yaseen Obaid Noori Ahmed Sharif [1] *, Dawood Salman Madab[2] and Hussein Ali Hindi[3]
Field Crops Department - College of Agriculture - Tikrit University
Field Crops Department - College of Agriculture - Tikrit University
Field Crops Department - College of Agriculture - Tikrit University
*Corresponding author's email:
yaseenobaidnoori@uokirkuk.edu.iq dawoodobaidy@tu.edu.iq husseinali@tu.edu.iq

Abstract

A field experiment was carried out during spring season of 2023 in Koldara area of Al-Tun Kubri district in Kirkuk Governorate. Experiment was applied according to Randomized Complete Block Design(R.C.B.D) in a Split- Split plot design with three replicates. Main plots included two levels of water stress were (50 and 70)% mean depleting available water and sub plots contains five levels of phosphate fertilizer were (0, 50, 75, 100 and 125) kg. $P_2O_5 \cdot H^{-1}$ and Sub plot included six cultivars of Sorghum were Giza, Enqath, Rabeh, Bohouth, Lilo, and J Cultivar recorded highest means of traits for crude protein and percentage of digested nutrients, record (10.65) and (57.48)%, respectively, while Bohouth cultivar recorded highest mean for ash percentage, reaching (8.85)%. Enqath cultivar achieved highest mean for fiber percentage and lowest desired mean for Hydrocyanic acid percentage. Hydrocyanic acid record (57.93) and (171.43)%, respectively, and normal irrigation treatment gave lowest percentage of hydrocyanic acid, amounting to (163.14)%, and level was 125 kg. P_2O_5 H^{-1} was given lowest desired mean hydrocyanic acid amounting to (132.08)%, and triple interaction treatment(cultivars x Normal irrigation x level of 125 kg P_2O_5 H^{-1}) achieved Record lowest desired mean hydrocyanic acid amounting to (130.01)%.

Keywords: Sorghum, Water stress, Phosphate fertilization, Qualitative Traits.

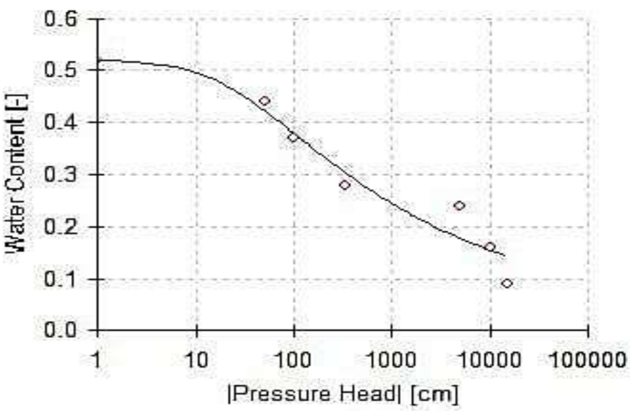
Introduction

Sorghum (*Sorghum bicolor* (L.) (Moench)) is one of important fodder crops of Poaceae family. It ranks fifth in terms of area and production in world after wheat, Rice, Barley and Maize. Its importance is due to its multiple uses. It is a food, fodder and industrial crop at same time, and a main food for population of a number of regions of continents of Asia and Africa [1], and its production per unit area reached (363.8) kg. per dunum and cultivated area is approximately(10007) dunum[2]. Iraq is one of developing countries in arid and semi-arid regions and most vulnerable country in Middle East to environmental problems due to water quality, soil salinity, air pollution, conflicts over water resources and deterioration of major ecosystems. Water stress is also one of main causes of severe food shortages around world as it contributes Problem of food shortage is exacerbated due to changes it causes in plant and this is reflected in all metabolic and vital processes and decline in plant productivity in particular[3]. It has become necessary to find modern means to improve growth and increase fodder production from Sorghum including use of chemical fertilizers one of which is fertilizer Phosphate:Phosphorus constitutes about 0.2% of dry weight of the plant, as it participates in formation of DNA, RNA, proteins, cellular membranes, enzyme conjugates and transport compounds. Therefore, it is called key to life and its deficiency leads to weakness of plant, small size of its leaves, weak stems, limited growth of roots, and an imbalance in percentage of dry matter between upper parts. To roots [4]. Cultivars differ in their phenotypic and resulting traits resulting from interaction between genetic and environmental variation. Each cultivar is characterized by certain traits that differ from other. given importance of Sorghum as fodder, it was necessary to search for a way to increase its production capacity with best quality. The research aims to determine best level of (70) % water stress treatment. Water stress, phosphate fertilizer, best cultivars, and interactions of three factors in studied Sorghum traits.

Material and Methods

A field experiment was carried out during spring season(2023) in field of a farmer in Koldara area of Al-Tun Kubri in Kirkuk Governorate and used two levels of water stress (50 and 70)% available water, with five levels of phosphate fertilizer are (0, 50, 75, 100 and 125) kg. $P_2O_5 \cdot H^{-1}$ and six cultivars of Sorghum are Giza, Enqath, Rabeh, Bohouth, Lilo, and J. and a composite sample was taken from experimental Soil to study its physical and chemical traits Table (1). while nitrogen fertilizer was added in form of urea(46 N%) as a source of nitrogen in an amount of (320) kg H^{-1} in twice, first after planting and second before flowering and potassium fertilizer (K_2O) was added as a source of potassium before planting, in an amount of 100 kg.H^{-1} **[5]**. Area each main plot was (1.5 x 2 x 6 = 18) m^2. Each experimental unit was designed with dimensions of (1 x 2) m^2 and distance between one line and another was (0.5) m and between one plant and another(1) m. Experiment was planted on April-10-2023 and harvested And he took the first portion of feed on a date on July-8-2023 and watering process was carried out according to full irrigation process up to four leaves. Plants thinned out after stage of appearance of four true leaves and (70) % water stress treatment was applied to them after appearance of fourth leaf in plant. Irrigation time was determined based on American evaporation basin, class A, a galvanized iron basin with a diameter of 1.2 m and a depth of 0.25 m.

The relationship between the volumetric moisture content (θ) and the tension (θ) of the study soil models was estimated in order to determine the moisture description curve, as different water potentials between (0.05 and 15) bar were applied after the soil was saturated with water for 24 hours. The Sintered Glass Funnels device was used for the two voltages (0 and 0.05) bar and the Pressure Plate device for the voltages (0.1, 0.33, 5, 10, 15) bar. Then the relationship between the volumetric moisture content and the water potential was drawn. The equation was used to match the relationship between volumetric moisture content(θ) and tension (θ) using the (RETC) program to obtain the best fit to the curve and extract the values of the parameters α, n, and m. **Figure (1) shows the moisture description curve for field soil before planting**.



This was done by erecting basin at a distance of 15 m from experiment site and raising it from surface of soil with a wooden board 0.12 m high in order to facilitate the movement of air from at bottom of basin **[6].** six cultivars of Sorghum were used in this study: Giza, Enqath, Rabeh, Bohouth, Lilo, and J and two levels of water stress: first: moisture depletion(50)% with Normal irrigation and second: moisture depletion (70)% stress treatment. Levels of phosphate fertilization were: first 0 kg. and 50 kg. and 75 and 100 and125 kg.P_2O_5 H^{-1} plants were mowed after plants reached(50)% flowering. Five plants were chosen randomly, leaving guard line plants for each experimental unit, and their mean was taken traits The following characteristics were studied Fiber percentage(%), crude Protein(%), Ash content(%),Total digestible nutrient (%) and Hydrocyanic acid per leaves (%).

Data for studied traits were analyzed using SAS statistical program and arithmetic means were compared according to Duncan's Multiple Range Test with a probability level of (0.05) **[7].**

Results and Discussion

Table(2) shows analysis of variance, represented by the means of squares of levels of water stress, levels of phosphate fertilizer, Cultivars, and their interactions. Mean squares of levels of water stress were significant at 1% probability level and for all studied traits. This variance between two levels of stress is attributed to important role of water in vital processes of plant, and it was mean squares of phosphate fertilizer are highly significant for all studied traits and reason is attributed to role of phosphorus in process of carbon assimilation, deepening of roots into soil formation of nucleic acids, and production of ATP.As for mean squares of cultivars, it was highly significant for all studied traits. The reason is due to genetic nature of cultivars and genes that carry them. Mean squares of two- and three-way interactions between three study factors were highly significant in studied traits. The reason for significant interaction is due to interaction of genetic and environmental factors in studied traits.

1- Fiber percentage (%) :

Results of Table (3) show that there are significant differences between levels of water stress and levels of phosphate fertilizer and cultivars and compatibility between them trait. It is noted from same table that there are significant differences between levels of water stress (50 and 70%), as treatment exceeded Normal irrigation, recording highest average for trait of (59.03)%, while stress level (70)% gave an mean of (55.55)%. The reason is attributed to exposure of plants to water stress, which causes a decrease in dry weight of plant and a loss of water inside plant cells, which led to a decrease in nutrients manufactured during process of carbon metabolism and thus a decrease in percentage of fiber in plants exposed to water stress. Statistical differences were significant between mean levels of phosphate fertilizer in trait, as level of 125 kg.P_2O_5 H^{-1} exceeded four fertilizer additions recording highest mean for trait, amounting to (60.32)%, while Control treatment gave lowest mean for trait, amounting to (55.0)%. This is due to increase in percentage fiber at level of kg.P_2O_5 H^{-1} increases amount of Available phosphorus in soil, which leads to an increase in growth of root system. Phosphorus also improves absorption of nitrogen and latter causes an increase in amino acids and nutrients manufactured from it through process of carbon metabolism, which leads to an increase in percentage of fiber [8]. Statistical differences between means of cultivars were significant for trait, as Enqath cultivar achieved highest mean for trait, amounting to (57.93)%, while Giza cultivar recorded mean similar to trait, amounting to (56.68)%. The reason for superiority of Enqath cultivar in traits is attributed to its genetic nature and its response to environmental conditions, which contributed to increasing percentage of fiber and this result is consistent with [9]. Arithmetic means had significant differences in trait between Interaction treatments cultivars and water stress, as compatible treatment (Enqath cultivar with normal irrigation treatment) excelled in giving highest mean for trait amounting to (59.75)%, while combined interaction treatment between Giza cultivar and water stress gave 70. lowest rate for trait was (54.89%). secondary interaction between cultivars and fertilizer additions was significant in trait, as combined treatment (cultivars and level 125) kg. $P_2O_5H^{-1}$ recorded highest mean for trait, amounting to (60.08)%. Lowest mean recorded in combined treatment (Giza cultivar and Control treatment) was (53.58)%.The Interaction treatments between levels of water stress and levels of phosphate fertilizer was significant in trait, as combined treatment(level 125) kg.P_2O_5 H^{-1} and normal irrigation treatment) achieved highest mean for trait, amounting to (61.34)%, while (70% water stress treatment with control treatment) was recorded. Lowest rate for trait was 51.94%. Triple Triple Interaction (Enqath cultivar, level 125 kg.P_2O_5 H^{-1}, and normal irrigation) recorded highest rate of trait, amounting to (61.83)%, while combinatorial treatment (cultivar Giza, Control treatment and water stress 70%) gave lowest rate of trait, amounting to (50.26)%.

2- crude Protein(%):

Results of table (4) indicate that there are significant differences between arithmetic means of cultivars, two levels of water stress and levels of phosphate fertilizer and correspondence between them in trait. It is noted from same table that normal irrigation treatment was superior in giving highest rate of trait, amounting to (10.67)%, The water stress level was 70%. The character istic Record the highest rating (10.23)%.This is due to the inability of the plant exposed to water stress to biosynthesize protein. Also water stress leads to e stimulation of protein-degrading enzymes, which led to a decrease in percentage of protein in plants exposed to water stress [10]. Differences between arithmetic means between levels of phosphate fertilizer were significant, as level exceeded 100 kg. P_2O_5 H^{-1} at other four levels, recording highest rate of trait amounting to (12.11)%. On other hand Control treatment gave lowest rate of (9.01)%. The reason is due to role of phosphorus in contributing to formation of a branched root system, which led to an increase in nitrogen absorption, and other contributed to an increase in percentage of protein in leaves of Sorghum plants, and this result is consistent with [11]. Statistical differences between means of cultivars were significant in trait, as J cultivar achieved highest mean for trait, amounting to (10.65)%, while Enqath cultivar recorded a lower average for trait, amounting to (10.18)%. The reason is attributed to variation of the cultivars in percentage of protein due to their genetic variation and difference in ability of their roots to absorb Nutrients, especially nitrogen and their transfer from source (leaves) to downstream (grains) and arithmetic means of Interaction treatments coefficients between cultivars and water stress were significant for trait, as Secondary interaction between cultivar and 50% water stress excelled in giving highest mean for trait, amounting to(11.00)%. While reaction treatment (Enqath cultivar and 70% water stress) gave lowest rate of the trait, amounting to (9.99)%. Arithmetic means had significant differences between cultivars and levels of phosphate fertilizer in trait, as combined treatment (Giza cultivar and level 100) kg. $P_2O_5H^{-1}$ excelled in recording highest mean for trait, amounting to (12.50)%, while compatible treatment (Enqath cultivar and Control treatment) recorded highest a mean for trait. Lowest mean for trait was (8.76)%. Means of Interaction treatments between levels of water stress and levels of phosphate fertilizer had significant differences in trait, as combined treatment (level 100 P_2O_5 H^{-1} and Control treatment) excelled in giving highest rate trait, amounting to (13.08)%. While compatible treatment (Control treatment and normal irrigation(50)% water stress treatment) recorded lowest trait rate of (8.73)%. Triple interaction between three study factors was significant in trait, as combined treatment (Giza cultivar, level 100 kg. P_2O_5 H^{-1} and normal irrigation(50)% water stress treatment) was recorded in giving highest mean for trait, amounting to (13.44)%, while compatible treatment (cultivar Enqath with Control treatment and treatment normal irrigation(50)% of water stress) Lowest trait rate was (8.63)%.

3- Ash content (%).

Table (5) shows that there are significant differences between levels of water stress and levels of phosphate fertilizer and cultivars, and compatibility between them in trait. It is noted from same table that water stress treatment exceeded 70% in giving highest mean for trait, which reached (8.82)%, while normal irrigation treatment recorded mean for trait, which reached (8.68).)%. This is due to fact that plants being exposed to water stress affects ash content in sorghum, as ash concentration increases when water stress increases due to greater concentration of elements in plant thus increasing percentage of ash in Sorghum plants exposed to water stress [10]. Statistical differences between mean levels of phosphate fertilizer were significant as level exceeded 125 kg. P_2O_5 H^{-1} on four fertilizer additives recorded highest rate of trait amounting to (9.140)%. On other hand, Control treatment gave a lower mean for trait, amounting to (8.490)%, and it did not differ significantly from 50 kg level. P_2O_5 H^{-1}, which recorded mean of (8.491)%. This is due to fact that treating plants with a high level of phosphorus led to an increase in e growth of root system of Sorghum plants and thus increased their ability to absorb elements, which was reflected in an increase in the ash content, and this result was consistent with [12].Arithmetic means of cultivars had significant differences in trait, as Bohouth Cultivar record highest mean for trait, amounting to (8.85)%, and it did not differ significantly from three cultivars (Lilo, Giza and Rabeh), with means reaching (8.80, 8.78, and 8.76)%, respectively. While cultivar achieved lowest rate of saving trait, amounting to (8.62)%, reason for difference between the cultivars in the percentage of ash is due to the genetic ability of the cultivar to absorb elements and this variation caused a difference in percentage of ash, and this result was consistent with results of [13]. Statistical differences between arithmetic means of interaction treatment coefficients for cultivars and two levels of water stress were significant in terms of trait, as iinteraction treatment(cultivar Bohouth and water stress treatment 70%) was superior in giving highest mean for the trait, amounting to (8.90)%, while interaction treatment (Enqath cultivar and water stress treatment 70%) gave highest average for trait, which amounted to (8.90)%. Lowest mean for trait was (8.50)%, and Interaction treatments interaction between cultivars and levels of phosphate fertilizer was significant in trait, as combined treatment (Giza cultivar and level of 125) kg. P_2O_5 H^{-1} excelled in achieving highest mean for trait, which amounted to(9.27)%, while lowest mean for trait was combined treatment (cultivar J and Control treatment) recorded (8.33%). Statistical differences were significant between means of two interaction coefficients between levels of water stress and levels of phosphate fertilizer in trait, as intervention treatment (level 125 kg. P_2O_5 H^{-1}) and water stress treatment 70%) achieved highest rate for trait amounting to (9.53)%, while combined treatment recorded (level 50 kg P_2O_5 H^{-1}) and normal irrigation treatment had lowest mean for trait (8.35%). Triple interaction between study factors was significant in terms of trait, as compatible treatment (cultivar Lilo, fertilizer level 75 kg. P_2O_5 H^{-1} and water stress 70)% was superior in giving highest rate of trait, amounting to (9.83)%, and did not differ significantly from compatible treatment (cultivar Research with the same fertilizer treatment and water stress (70%) gave an mean of (9.79)% for trait, while combined treatment (Rabeh cultivar, Control treatment and normal irrigation treatment) gave lowest mean of (8.16)%.

4- Total digestible nutrient (%):

Results of table (6) showed that there were significant differences between e arithmetic means of levels of water stress and levels of phosphate fertilizer and cultivars and their Interaction between them in percentage of digested nutrients, as normal irrigation (50)% water stress treatment excelled in giving highest rate of trait, amounting to (57.37)%, while water stress treatment gave a 70% rate of trait. It reached (57.16)%. The reason is attributed to transformation of starch into simple sugars when plant is exposed to water stress and this change is one of plant's defenses against drought. Starch does not change water potential of leaves, but soluble sugars reduce osmotic potential of plant and thus increase power of water absorption to increase potential difference between soil and plant[14].

Statistical differences between arithmetic means of phosphate fertilizer levels were significant as level exceeded 100 kg. P_2O_5 H^{-1} at four fertilizer levels recorded highest rate of the trait amounting to (58.93)%. In contrast, Control treatment gave an mean of trait amounting to (.9355)%. The reason is due to participation of phosphorus in many vital processes of plant, especially process of carbon metabolism, thus increasing accumulation of stored nutrients. In addition, it encourages plant roots to increase their absorption of nutrients, thus increasing proportion of digested nutrients [15]. As for the cultivars, the two cultivars J and Giza recorded highest rates for trait, reaching (57.48) and 57.47%, respectively, while cultivar Enqath recorded a lower mean for the trait, amounting to (56.94)%. The reason is attributed to difference in percentage of digested food material between cultivars and genetic variation of cultivars in trait. It is noted from same table that there are significant differences between means of Interaction treatments between cultivars and two levels of water stress in trait, as combined treatment (cultivar J and (normal irrigation (50)% water stress treatment) excelled in giving highest mean for trait amounting to (57.37)%, while interaction treatment between two cultivars (Enqath, Rabeh, and water stress (70%), lowest mean for trait was (56.88%), and Interaction treatments coefficients between cultivars and levels of phosphate fertilizer were significant in the trait, as combined treatment (Giza cultivar and level 100 kg. P_2O_5 H^{-1}) excelled in giving highest mean for trait, which reached (59.35%) As for lowest average achieved by combined treatment (Enqath cultivar and Control treatment), it amounted to (55.59)%. Means of Interaction treatments between levels of water stress and levels of phosphate fertilizer were significant of trait, as the compatible treatment(level of 100 kg.P_2O_5 H^{-1}) and normal irrigation treatment) excelled in giving highest rate of trait, amounting to (59.83)%, while the combined treatment (level of water stress of 70) was recorded. % and Control treatment) Lowest meanfor trait amounted to (55.43)%, and triple interaction coefficients were significant for trait, as triple treatment(Giza cultivar, level 100 kg.P_2O_5 H^{-1}) (Enqath cultivar, Control treatment, and normal irrigation (50)% water stress treatment) ,Lowest for trait reached (55.24)%.

5- Hydrocyanic acid per leaves (%).

Results of table (7) the presence of significant differences between means of levels of water stress and e levels of phosphate fertilizer and cultivars and their differences in percentage of hydrocyanic acid. It is noted from same table that there are significant differences between levels of water stress (50 and 70)% in trait, as normal irrigation treatment excelled in giving it lowest desirable mean for trait, amounting to (163.34)%, while (70)% water stress treatment gave highest undesirable mean for trait , which amounted to (186.59%. The reason is that percentage of hydrocyanic acid in Sorghum is affected by water stress, causing changes in metabolic activity of plant. When plant is exposed to water stress, changes occur in activity of many enzymes and metabolic pathways inside leaves. These changes lead to an increase in production of hydrocyanic acid as part of response. Plant for stress. Statistical differences between means of phosphate fertilizer were significant, as level exceeded 125 kg. P_2O_5 H^{-1} at four phosphate fertilizer levels, recording lowest desired mean for trait, which reached (132.08)%, while level gave 50 kg. P_2O_5 H^{-1} The highest undesirable rate for trait reached (202.81)%. The reason is due to fact that phosphorus reacts with hydrocyanic acid (HCN) to form hydrogen phosphate (PH3) and water (H_2O). This reaction reduces percentage of hydrocyanic acid in leaves and this is what was mentioned by [16]. The arithmetic means for cultivars were significant for trait, as Enqath cultivar achieved lowest desired rate for trait amounting to (171.43)%, while Bohouth cultivar recorded highest mean for trait, amounting to (178.44)%. The reason for this discrepancy between cultivars in trait may be due to their difference in genetic nature and genes that carry this trait. Classes This is consistent with [13] and [17]. It is noted from same table that there are significant differences between means of Interaction treatments between cultivars and two levels of water stress in trait, as treatment (Giza cultivar and the 70 water stress treatment) excelled in giving highest undesirable mean for trait, amounting to (191.02)%, and did not differ significantly from treatment. The compatibility (Bohouth cultivar with same treatment) recorded mean of (190.48)%, while compatibility treatment (Enqath cultivar and normal irrigation treatment) gave lowest desired rate for trait, which amounted to (160.37)%. The two-sided interaction between means of cultivars and levels of phosphate fertilizer was significant for trait, as compatible treatment (Enqath cultivar and level of 125 kg. P_2O_5 H^{-1}) excelled by giving lowest desired mean for trait, amounting to (130.94)%. While compatible treatment (Bohouth cultivar and level 50 kg. P_2O_5 H^{-1}) gave highest undesirable mean for trait, amounting to (213.22)%. The Interaction treatments interaction between levels of water stress and levels of phosphate fertilizer was significant in trait, as compatible treatment (level of 125 kg. P_2O_5 H^{-1} and normal irrigation treatment) achieved a desirable mean for trait of (131.06)%. While Interaction between (level 50 kg. P_2O_5 H^{-1} and water Stress treatment 70)% recorded highest undesirable rate of trait, amounting to (221.65)%. Three-way interaction of means of three study factors was significant for trait, as the compatible treatment (Enqath cultivar, level 125 kg. P_2O_5 H^{-1}, and normal irrigation treatment) achieved e lowest desired mean for trait, amounting to (130.01)%. While triple treatment (Bohouth cultivar, level 50 kg. P_2O_5 H^{-1} and water Stress treatment 70)% gave highest undesirable rate for trait, amounting to(235.61)%.

Table (1):Chemical and physical traits of soil at experiment location and at a depth of (30)cm.

Soil texture	O.M	Ready potassium	Total phosphorus	Total Nitrogen	E.C	pH	Traits
-	(%)	(ppm)	(ppm)	(%)	DSM $^{-1}$	-	Measuring unit
Loamy sand	0.97	143	7	32	2.29	7.43	Unit

physical traits of soil at experiment location and at a depth of (30)cm

Volumetric moisture content at 15 bar tension	Volumetric moisture content at tension is 0.33 bar	Total porosity	True density	Bulk density	Traits
cm^3 cm^{-3}	cm^3 cm^{-3}	%	mg. m^{-3}	mg. m^{-3}	Measuring unit
0.09	0.28	49.0	2.65	1.35	Unit

Table (2) Mean squares of water stress and phosphate fertilizer levels for Sorghum cultivars and studied traits.

M.S						
Hydrocyanic acid per leaves (%)	Total Digestible Nutrient (%)	Ash content (%)	crude Protein (%)	Fiber percentage (%)	d.f	S.O.V
6.684	0.0006	0.036	0.0004	0.010	2	R
24743.033**	2.003**	0.907 **	8.584**	543.194**	1	(A)
6.677	0.00006	0.021	0.0001	0.005	2	R*A
28643.233**	46.527**	2.715**	50.668**	161.353**	4	(B)
1698.148**	14.700**	3.734**	12.278**	21.344**	4	A*B
7.032	0.0006	0.017	0.0006	0.004	8	R*B
6.982	0.001	0.026	0.001	0.005	8	R*AB
208.019**	1.695**	0.224**	1.185**	6.783**	5	C
68.573**	0.308**	0.160**	0.273**	0.238**	5	AC
44.646**	0.449**	0.129**	0.421**	1.075**	20	BC
109.577**	0.273**	0.116**	0.247**	0.365**	20	ABC
6.862	0.00128	0.035	0.00121	0.006	100	Error
					179	Total

Significant at probability level (1)% = **

A = water stress **B = Phosphate fertilizer** **C =cultivars**

Table(3): Arithmetic means of water stress, phosphate fertilization levels, cultivars and their interactions in fiber percentage (%).

Means cultivars	water stress % 70					50					phosphate fertilization / cultivars
	125	100	75	50	0	125	100	75	50	0	
56.68 f	59.30 j	56.42 uv	54.98 vw	53.50 wx	50.26 z	60.86 e	59.46 hi	58.58 m	56.53 u	56.91 s	Giza
57.93 a	59.33 ij	56.86 s	56.30 uv	54.85 w	53.26 x	61.83 a	60.56 f	59.15 k	58.07 o	59.13 k	Enqath
57.63 b	59.34 ij	56.71 t	56.17 v	54.59 w	53.33 x	61.56 b	59.46 hi	58.89 l	57.83 p	58.43 n	Rabeh
56.90 e	59.30 j	56.47 u	55.22 vw	53.68 wx	50.71 y	61.15 d	59.49 h	58.87 l	56.62 tu	57.45 q	Bohouth,
57.49 c	59.07 k	56.61 tu	56.18 v	54.06 wx	53.26 x	61.40 c	59.75 g	58.80 l	57.23 r	58.55 mn	Lilo
57.10 d	59.44 hij	56.61 tu	56.17 v	53.77 wx	50.82 y	61.22 d	59.47 hi	58.85 l	56.87 s	57.84 p	J

125	100	75	50	0	phosphate fertilization / water stress
61.34 a	59.70 b	58.85 d	57.19 f	58.05 e	50
59.30	56.61	55.84	54.07	51.94	70

c	g	h	i	j	

125	100	75	50	0	phosphate fertilization / cultivars	70	50	Water stress / cultivars
60.08 e	57.94 j	56.78 n	55.01 v	53.58 x	Giza	54.89 l	58.47 f	Giza
60.58 a	58.71 f	57.72 k	56.46 22	56.19 p	Enqath	56.12 g	59.75 a	Enqath
60.45 b	58.09 h	57.53 l	56.21 p	55.88 q	Rabeh	56.03 h	59.23 b	Rabeh
60.23 d	57.98 ij	57.04 m	55.15 t	54.08 w	Bohouth,	55.08 k	58.71 e	Bohouth,
60.24 d	58.18 g	57.49 l	55.64 r	55.91 q	Lilo	55.84 i	59.15 c	Lilo
60.33 c	58.04 hi	57.51 l	55.32 s	54.33 v	J	55.36 j	58.85 d	J
60.32 a	58.15 b	57.34 c	55.63 d	55.00 e	Means phosphate fertilization	55.55 b	59.03 a	Means Water stress

*** Similar letters have no significant differences between them.**

Table(4): Arithmetic means of water stress, phosphate fertilization levels, cultivars and their interactions in crude Protein (%).

Means cultivars	water stress % 70					50					phosphate fertilization / cultivars
	125	100	75	50	0	125	100	75	50	0	
10.60 b	9.77 pq	11.56 h	11.32 j	10.55 m	9.50 r	10.49 mn	13.44 a	10.69 l	9.79 pq	8.90 v	Giza
10.18 e	9.75 pq	10.76 kl	10.61 lm	9.98 op	8.90 vw	11.37 ij	12.83 d	10.01 o	9.00 t	8.63 z	Enqath
10.25 d	9.84 p	10.83 k	10.75 kl	9.57 qr	8.96 u	11.46 i	12.85 d	10.20 no	9.37 s	8.68 y	Rabeh
10.61 b	10.42 mn	11.36 ij	10.99 jk	9.58 qr	9.49 r	11.97 e	13.35 b	10.56 m	9.62 qr	8.77 w	Bohouth,
10.42 c	10.05 o	11.02 jk	10.76 kl	9.86 p	9.37 s	11.70 g	12.97 c	10.31 n	9.47 r	8.70 xy	Lilo
10.65 a	10.17 no	11.33 j	10.82 k	9.71 q	9.45 rs	11.78 f	13.02 c	12.01 e	9.45 rs	8.73 x	J

125	100	75	50	0	phosphate fertilization / water stress
11.46 b	13.08 a	10.63 e	9.45 h	8.73 j	50
10.002 f	11.14 c	10.87 d	9.87 g	9.28 i	70

125	100	75	50	0	phosphate fertilization / cultivars
10.13 p	12.50 a	11.01 i	10.17 p	9.20 t	Giza
10.56 m	11.79 f	10.31 o	9.49 s	8.76 x	Enqath
10.65 l	11.84 e	10.48 n	9.47 s	8.82 w	Rabeh
11.19 h	12.36 b	10.77 k	9.60 r	9.13 u	Bohouth,
10.87 j	11.99 d	10.53 m	9.66 q	9.03 v	Lilo
10.97 i	12.17 c	11.41 d	9.58 r	9.09 u	J
10.73 c	12.11 a	10.75 b	9.66 d	9.01 e	Means phosphate fertilization

70	50	Water stress / cultivars
10.54 e	10.66 c	Giza
10.001 j	10.37 g	Enqath
9.99 j	10.51 f	Rabeh
10.37 g	10.85 b	Bohouth,
10.21 i	10.63 d	Lilo
10.29 h	11.00 a	J
10.23 b	10.67 a	Means Water stress

*** Similar letters have no significant differences between them.**

Table(5): Arithmetic means of water stress, phosphate fertilization levels, cultivars and their interactions in ash content (%).

water stress %											
Means cultivars	70					50					phosphate fertilization / cultivars
	125	100	75	50	0	125	100	75	50	0	
8.78 a	9.70 ab	9.13 efgh	8.40 m-t	8.76 h-m	8.46 l-t	8.85 hijk	8.79 h-l	9.03 fghi	8.33 q-t	8.38 n-t	Giza
8.62 c	9.53 abcd	8.82 h-l	8.23 rst	8.31 q-t	8.82 h-l	8.59 j-r	8.36 o-t	8.72 i-o	8.47 k-t	8.33 p-t	Enqath
8.76 ab	9.43 bcde	9.25 defg	8.47 k-t	8.71 i-p	8.61 j-q	8.80 h-l	8.73 i-o	9.24 defg	8.21 st	8.16 t	Rabeh
8.85 a	9.50 abcd	8.79 h-l	8.38 n-t	8.83 h-l	8.50 k-t	9.03 fghi	8.63 j-p	9.79 a	8.30 q-t	8.77 h-m	Bohouth,
8.80 a	9.61 abc	9.05 fghi	8.51 k-t	8.53 k-t	8.40 m-t	8.59 j-s	8.38 n-t	9.83 a	8.40 m-t	8.75 i-m	Lilo
8.67 bc	9.41 bcde	8.96 ghij	8.49 k-t	8.61 j-r	8.39 m-t	8.61 j-r	8.26 q-t	9.33 cdef	8.40 m-t	8.27 q-t	J

125	100	75	50	0	phosphate fertilization / water stress
8.74 d	8.52 ef	9.32 b	8.35 g	8.44 fg	50
9.53 a	9.00 c	8.41 fg	8.62 de	8.53 ef	70

125	100	75	50	0	phosphate fertilization / cultivars	70	50	Water stress / cultivars
9.27 a	8.96 bcd	8.72 efg	8.54 ghi	8.42 hi	Giza	8.89 ab	8.67 cde	Giza
9.06 abcd	8.59 gh	8.47 ghi	8.39 hi	8.58 ghi	Enqath	8.74 bcd	8.50 f	Enqath
9.12 abc	8.99 bcd	8.85 def	8.46 ghi	8.38 hi	Rabeh	8.63 de	8.89 ab	Rabeh
9.26 a	8.71 efg	9.08 abcd	8.57 ghi	8.63 fgh	Bohouth,	8.90 a	8.80 abc	Bohouth,
9.10 abcd	8.72 efg	9.17 ab	8.46 ghi	8.58 ghi	Lilo	8.82 abc	8.79 abc	Lilo
9.01 bcd	8.61 fgh	8.91 cde	8.50 ghi	8.33 i	J	8.77 abcd	8.57 ef	J
9.14 a	8.87 b	8.76 c	8.49 d	8.49 d	Means phosphate fertilization	8.82 a	8.68 b	Means Water stress

*** Similar letters have no significant differences between them.**

Table(6): Arithmetic means of water stress, phosphate fertilization levels, cultivars and their interactions in total digestible nutrient (%).

% water stress											
Means cultivars	70					50					phosphate fertilization / cultivars
	125	100	75	50	0	125	100	75	50	0	
57.47 ab	56.42 o	58.48 gh	58.34 gh	57.63 ij	56.77 lm	57.06 k	60.22 a	57.43 jk	56.64 mn	55.68 t	Giza
56.94 e	56.39 op	57.62 ij	57.50 j	56.95 kl	55.93 s	57.91 hi	59.51 ef	56.68 m	55.71 st	55.24 z	Enqath
57.04 d	56.49 n	57.71 i	57.66 ij	56.54 n	56.00 r	58.02 hi	59.61 d	56.90 l	56.10 q	55.35 xy	Rabeh
57.46 b	57.09 k	58.27 h	57.97 hi	56.62 mn	56.73 lm	58.57 g	60.13 b	57.27 k	56.45 no	55.50 u	Bohouth,
57.22 c	56.72 lm	57.90 hi	57.66 ij	56.88 l	56.42 o	58.27 h	59.72 d	57.01 k	56.25 p	55.35 xy	Lilo
57.48 a	56.82 l	58.23 h	57.73 i	56.74 lm	56.68 m	58.37 gh	59.78 c	58.78 f	56.26 p	55.44 v	J

125	100	75	50	0	phosphate fertilization / water stress
58.03 b	59.83 a	57.34 d	56.23 h	55.43 i	50
56.66 f	58.03 b	57.81 c	56.89 e	56.42 g	70

125	100	75	50	0	phosphate fertilization / cultivars	70	50	Water stress / cultivars
56.74 p	59.35 a	57.88 h	57.13 n	56.23 t	Giza	57.53 c	57.40 d	Giza
57.15 n	58.56 f	57.09 o	56.33 s	55.59 y	Enqath	56.88 j	57.01 i	Enqath
57.25 m	58.66 e	57.28 m	56.32 s	55.67 x	Rabeh	56.88 j	57.20 g	Rabeh
57.83 i	59.20 b	57.62 j	56.53 qr	56.12 u	Bohouth,	57.34 e	57.58 b	Bohouth,
57.50 k	58.81 d	57.34 l	56.56 q	55.89 w	Lilo	57.12 h	57.32 e	Lilo
57.60 j	59.01 c	58.25 g	56.50 r	56.06 v	J	57.24 f	57.73 a	J
57.34 c	58.93 a	57.58 b	56.56 d	55.93 e	Means phosphate fertilization	57.16 b	57.37 a	Means Water stress

*** Similar letters have no significant differences between them.**

Table(7): Arithmetic means of water stress, phosphate fertilization levels, cultivars and their interactions in hydrocyanic acid per leaves (%).

Means cultivars	70					50					phosphate fertilization / cultivars
	125	100	75	50	0	125	100	75	50	0	
176.43 b	134.48 w	175.62 mno	208.52 cd	233.06 a	203.42 ef	131.73 w	161.48 s	185.84 kl	163.14 rs	167.09 qr	Giza
171.43 d	131.87 w	170.74 pq	204.73 def	210.05 c	195.05 hi	130.01 w	144.31 v	177.70 mn	186.31 jkl	163.52 rs	Enqath
172.52 c	132.52 w	170.79 pq	205.32 cdef	210.11 c	196.00 h	130.75 w	149.19 u	179.48 m	186.81 jkl	164.24 rs	Rabeh
178.44 a	133.45 w	174.62 nop	207.90 cde	235.61 a	200.81 fg	131.63 w	157.04 t	184.88 kl	190.83 ij	167.66 qr	Bohouth,
174.22 c	132.94 w	172.31 op	207.01 cde	220.23 b	196.20 h	131.02 w	150.09 u	179.29 m	187.39 jkl	165.73 rs	Lilo
176.16 b	133.33 w	174.46 nop	207.33 cde	220.83 b	198.47 hg	131.21 w	155.66 t	183.80 l	189.35 jk	167.15 qr	J

Water stress % is the heading over the 70 and 50 column groups.

125	100	75	50	0	phosphate fertilization / water stress
131.06 j	152.96 h	181.83 e	183.97 d	165.89 g	50
133.10 i	173.09 f	206.80 b	221.65 a	198.32 c	70

125	100	75	50	0	phosphate fertilization / cultivars	70	50	Water stress / cultivars
133.10 m	168.55 i	197.18 c	185.25 f	198.10 c	Giza	191.02 a	161.85 ef	Giza
130.94 m	157.52 l	191.21 e	179.28 h	198.18 c	Enqath	182.49 c	160.37 f	Enqath
131.63 m	159.99 kl	192.40 e	180.12 gh	198.46 c	Rabeh	182.95 c	162.09 ef	Rabeh
132.54 m	165.83 ij	196.39 e	184.23 f	213.22 a	Bohouth,	190.48 a	166.40 d	Bohouth,

131.98 m	**161.20 k**	**193.15 de**	**180.96 gh**	**203.81 b**	**Lilo**	**185.74 b**	**162.70 e**	**Lilo**
132.27 m	**165.06 j**	**195.56 cd**	**182.81 fg**	**205.09 b**	**J**	**186.88 b**	**165.43 d**	**J**
132.08 e	**163.02 d**	**194.31 b**	**182.108 c**	**202.81 a**	**Means phosphate fertilization**	**186.59 a**	**163.14 b**	**Means Water stress**

*** Similar letters have no significant differences between them.**

Conclusion

We conclude from the research that Enqath Cultivar is superior in percentage of fiber and hydrocyanic acid, Research cultivar is superior in the percentage of ash, and two cultivars J and Giza in percentage of digested nutrients and protein, and they exceed level of 125 kg. P_2O_5 H^{-1} in all traits except proportions of protein and digested nutrients. The normal irrigation treatment excelled in all characteristics except ash percentage,While the compatible treatment (Enqath Cultivar, normal irrigation and level 125 kg. P_2O_5 H^{-1}) recorded the lowest desired average amount of hydrocyanic acid. It is possible to benefit from the Enqath cultivar in future breeding programs and fertilization at the level of 125 kg. P_2O_5 H^{-1} in obtaining the best quality Traits in Sorghum crop, and that exposing Sorghum crops to water stress causes a deterioration in the quality Traits of the feed.

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