



## **IMPROVING YIELD AND WATER USE EFFICIENCIES OF TWO SORGHUM CULTIVARS IRRIGATED BY SURFACE AND DRIP IRRIGATION SYSTEMS AND FERTILIZED BY NITROGEN**

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### **ABSTRACT :**

A field experiment was carried out during two successive seasons (summer 2003 and 2004) on two sorghum cultivars (Shandaweel-2 hybrid and Dorado variety) using surface and drip irrigation systems under certain levels of nitrogen fertilization (75, 100 and 125 kg N/fed); to study their effects on yield and its components, concentrations of N, P and K and protein content in grains as well as, evaluation of N recovery, N-use and water use efficiencies. The results indicated the following:-

- 1-The highest values of panicle length, diameter and weight as well as 1000 – grain weight and shelling % of sorghum plants were obtained from Shandaweel –2 hybrid using drip irrigation and receiving 125 kg N/fed.
- 2-The highest grain yield (20.34 ard/fed) was obtained from Shandaweel-2 hybrid that received 125 kg N/fed under the drip irrigation system.
- 3-Concentrations of N, P and K as well as protein content of grains were significantly increased using drip irrigation system compared to surface irrigation, but nitrogen fertilization, exerted a significant influence on all traits.
- 4-The nitrogen recovery and N use efficiency significantly affected by all interactions under study. The highest value of N recovery (58.58 kg N/fed) was obtained from Shandaweel-2 hybrid that received the highest N level (125 kg N/fed) under drip irrigation system. The highest value (58.18%) of N use efficiency was obtained from Shandaweel-2 hybrid that received the lowest N level (75 kg N/fed) under drip irrigation.
- 5-The water use efficiency was greatly affected by all interactions under study. The highest value (2.71 kg grains/m<sup>3</sup> water) was obtained from Shandaweel-2 hybrid that received the highest N level (125 kg N/fed) under drip irrigation.

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### **INTRODUCTION:**

Grain sorghum (*Sorghum bicolor* (L) Moench) is one of the most important grain crops for vast number of people in Upper Egypt

especially in Assiut and Sohag Governorates. Nitrogen fertilizer levels and irrigation systems are very important agricultural practices for

sorghum, which greatly affect yield and its components.

Water supply is a limiting factor for crop production. For sustainable agriculture, it is desirable to obtain higher grain yields using the least amount of irrigation water. Grain yield was affected by both the magnitude of water deficit and the stage of growth subjected to deficit (Salter and Good, 1967). Insufficient water supply caused by prolonging irrigation intervals, and or decreasing the available moisture in the soil clearly inhibit plant growth in terms of leaf area and plant height (Porro and Cassel, 1986). Furthermore, yield of maize and its related characters were reported to decline due to water stress (Bakelana *et al.* 1986). Thompson and Chase (1992) concluded that irrigation water supply should be limited; the best strategy would be through avoiding moisture stress during tailoring to spike emergence stages. Many researchers reported the importance of availability of adequate amounts of irrigation water to grow sorghum as reported by Badawi *et al.* (1988) and Ibrahim *et al.* (1992). Heatherly *et al.* (1990) indicated that the yield and seed weight of sorghum increased with increasing the number of irrigations.

Adams and Stevenson (1990) emphasized that using drip irrigation system to deliver continuous and adequate water supply into plant root zone and to keep the soil moisture content between 70 and 85% of its water holding capacity maximized the production of potato plants. Keeping soil water content at more than 85% of its maximum holding capacity by daily application of higher amount of water through the drip irrigation system significantly increased the tuber production. However, this increase may not be sufficient to compensate the high cost of operating energy. Abdel-Mawly (1993) and Gaber (2000) found that the values of water use efficiency of grain

crops were significantly increased as soil moisture levels decreased and vice – versa.

Grain yield was reported to be significantly reduced due to increasing the irrigation interval as a result of depression in yield attributes, particularly when the increase is imposed late in the season. The highest grain yield, grain protein content and N recoveries were recorded to be obtained with irrigation at 10-day intervals throughout the growing season (Sadik *et al.* 1996; El-Nager, 2003 and Abdel-Mawly and Zanouny, 2005). Ragheb *et al.* (2000) pointed out that the water use efficiency increased under the drip irrigation system compared with the other methods of water application.

Singh and Dixit (1989) pointed out that application of nitrogen significantly improved the grain crops per unit of water applied up to 120 kg/ha. Abdel-Mawly (1993) found that increasing N-application rate up to 150 kg N/fed resulted in highly significant increases in water use efficiency compared with the other N rates applied, i.e., 60, 90 and 120 kg N/fed. Ragheb and El-Nagar (1997) reported that the application of 125 kg N/fed produced the highest grain yield of 15.1 ard/fed. under Upper Egypt conditions. Suraked and Intal (1997) found that sorghum grain yields increased with increasing N fertilizer rates. Eweis *et al.*, (1998) indicated that applying 100kg N/fed under 6 irrigations produced the highest grain yield/fed. of sorghum, while under 4 and 5 irrigations, 80 kg N/fed was the most effective N-rate. Mehasen (1999) indicated that nitrogen fertilizer rates had a significant influence on all studied traits (yield and yield components). Mourad *et al.*, (2000) found that panicle weight, grain weight per panicle, 1000 – kernel weight, green yield, total biomass and grain yield characters of sorghum increased by increasing number of irrigations from 2 to 5 irrigations.

Latif, *et al.*, (2000), and Allam *et al.*, (2002) reported that nitrogen application increased panicle width, weight and length. El-Aref and Ibrahim (2004) reported that increasing nitrogen fertilizer level up to 100 kg N/fed significantly increased head length, diameter and weight, grain yield per plant, 1000- grain weight and grain yield per feddan of sorghum as compared with the crops of the other two nitrogen levels (60 and 80 kg N/fed).

Therefore, the aim of this study is to evaluate the response of two sorghum cultivars to N fertilization levels and irrigation systems.

## MATERIALS AND METHODS:

The present investigation was carried out during summer growing seasons of 2003 and 2004 at the Experimental Farm, Faculty of Agriculture, Al-Azhar University, Assuit Governorate, Egypt to study the effect of nitrogen fertilization levels (75, 100 and 125 kg N/fed) under surface and drip irrigation systems on yield and its components of two sorghum varieties (Shandaweel – 2 hybrid and Dorado variety).

The sorghum grains were sown in the 10<sup>th</sup> of June in both seasons, in rows of 60 cm apart at spacing 20 cm between hills. The commonly known (Afeer) in hills method of sowing was followed. After 18 days from planting, plants were thinned into two plants per hill. In the drip irrigation system, irrigation water was applied daily for a half hour at a rate of 20 m<sup>3</sup>/h/fed during the two growth seasons (2003 and 2004). The total amount of irrigation water applied

between planting and harvesting was 1290 and 1120 m<sup>3</sup>/fed for both growing seasons, respectively. However, the total amount of surface irrigation was 1950 and 1650 m<sup>3</sup>/fed for the 2003 and 2004 seasons, respectively. The irrigation water was measured using water gauges installed at the pumping unit. Calcium superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) was added during bed preparation at the rate of 100 kg/fed. The nitrogen fertilization levels were applied in the form of urea (46.5% N) in two equal doses. The 1<sup>st</sup> dose was added after thinning and the 2<sup>nd</sup> one was at 45 days from planting. The other recommended cultural practices were carried out during the two seasons. The preceding crop was wheat (*Triticum aestivum* L.) in both seasons.

The treatments were arranged in a split – split plot design with four replications, where the irrigation regime was in the main plot, the variety was in the sub-plot, and nitrogen level was in the sub sub-plot.

Each sub sub-plot area was 1/400 feddan (3 x 3.5 m) including 5 rows of 3.5 m long and 60 cm apart.

Soil samples from surface (0-30 cm) and subsurface (30-60) layers were collected from each treatment air-dried, ground and subjected to the determination of available nutrients (N, P and K) as outlined by Page *et al.* (1982).

The main soil properties of the experimental field before cultivation are presented in Table (1).

Table (1): Main soil properties of the studied soil.

Soil depth (cm)	pH*	EC** (dS/m)	Soluble ions (meq./L)							Nutrients (ppm)		
			HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>=</sup>	Ca <sup>+2</sup>	Mg <sup>+2</sup>	Na <sup>+</sup>	K <sup>+</sup>	N	P	K
0-30	8.50	0.23	0.05	1.70	0.72	0.50	0.45	1.48	0.03	45.0	9.50	365
30-60	8.52	0.26	0.10	1.55	0.89	0.35	0.60	1.57	0.02	35.0	9.10	307

**\*pH in 1:2.5 soil to water suspension.**

**\*\*EC in 1:5 soil to water extract.**

## Data recorded:

At the harvest time, one medium row was taken from each sub-sub plot in which the plant, were harvested and grain yield (ard/fed) was determined. Panicle length (cm), panicle diameter (cm), panicle weight (gm), 1000-grain weight (gm), and shelling %, for each sub sub-plot were also recorded. Grains samples were dried, ground, wet digested (Thomas *et al.*, 1967), and then subjected to the determination of N, P and K as described by Cottenie *et al.* (1982), crude protein content was estimated by multiplying N% in sorghum grain by a factor of 5.75 according to A.O.A.C. (1985) method.

The N recovery in grains was calculated according to Fried and Middleboe (1977) as follows:

$$\text{N-recovery (kg/fed)} = \text{N\% in grains} \times \text{grain yield (kg/fed)}.$$

The N use efficiency (N recovered %) was also calculated as of N recovered in grain as % of N applied as fertilizer (Thompson *et al.*, 2000), The water use efficiency (WUE) was calculated according to F.A.O (1982) as follows:

The ratio of crop yield (y) to the total amount of irrigation water use in the field for the growth season (IR),

$$\text{WUE (Kg/m}^3\text{)} = \text{Y(kg)/IR (m}^3\text{)}$$

Data were statistically analyzed separately for each season. Bartlett test of variance homogeneity was carried out before the combined analysis (Snedecor and Cochran, 1980). Analysis of variance for all characters was made according to Gomez and Gomez (1984). Means were compared using the L.S.D. at 5% level.

## RESULTS AND DISCUSSION:

Bartlett test of homogeneity indicated that the variance of data of both seasons was

insignificant. Thus, combined analysis was carried out for data for all traits. Year effect and its interaction with the factors under investigation were insignificant. Accordingly, means of both seasons were calculated and are given in the discussion below.

### I-Panicle Characters, 1000-Grain Weight and Shelling (%):

The combined analysis of the data as shown in Table (2) revealed that irrigation system, i.e., surface and drip irrigation, exerted a significant influence on a panicle length, diameter and weight. It is clear from these data that the drip irrigation system was superior for all these traits, as compared to the surface irrigation system. Irrigation that was applied day after day during drip irrigation system results in keeping the soil moisture content in the root zone. These results concede with those obtained by Badawi *et al.* (1988) and Ibrahim and El-Hosary (1992) regarding the importance of availability of adequate amounts of irrigation water to growing sorghum.

Regarding varieties i.e., Shandaweel-2 and Dorado variety, the data in the Table (2) indicated that cultivars exerted a significant influence on panicle length, diameter and weight, 1000 – grain weight and shelling %. It is clear from these data that plants of Shandaweel-2 hybrid were superior for all characters under study, compared to Dorado variety. The differences between cultivars are mainly due to the interaction between their genetic make up during growth periods and to the environmental factors prevailing during their development. These results are in an agreement with those reported by Yousef *et al* (1996), Allam *et al.* (2002) and El-Aref and Ibrahim (2004).

Nitrogen fertilization to grain sorghum cultivars exerted a significant influence on panicle length, diameter and weight, 1000- grain

weight and shelling (%). Data revealed that increasing N level increased panicle length, diameter and weight, 1000 – grain weight and shelling (%). The maximum values of these characters were obtained when the highest level of N was applied (125 kg N/fed). It is clear from these data that N fertilization to grain sorghum enhanced the vegetative growth of the plants, increased photosynthetic activity and the metabolites required to produce vigorous growth and consequently produced wide and heavy panicles. These results are in the same line with those reported by Eweis *et al.* (1998) and Mourad *et al.* (2000).

The interaction between irrigation systems and varieties or nitrogen fertilizer, exerted also significant influence on panicle length, diameter and weight as well as 1000–grain weight and shelling (%), Table (2). In general, the highest values of panicle length, diameter and weight as well as 1000–grain weight and shelling (%) (30.82 cm, 8.88 cm, 147.3g, 35.38 g and 76.94%, respectively) were obtained from Shandaweel-2 hybrid that received the highest nitrogen level (125 kg N/fed) and irrigated by drip irrigation system.

## II-Grain Yield:

Data in Table (3) indicate that irrigation systems significantly affected grain yield. Results indicated that the drip irrigation system gave higher values of grain yield (17.45 ard/fed) and relative yield percentage (137.07%) compared with the surface irrigation system. Drip irrigation may keep the moisture status in root zone of plants near the field capacity and reduce the occurrence of water stress on plants especially during the reproduction stage of growth. This could be due to the increase in the available soil moisture, which enhance ion uptake and photosynthetic metabolic

translocation from leaves to grain. Thus, the beneficial effect of the available soil moisture is reflected favorably on grain yield and its attributes and vice-versa. These results are in accordance with those obtained by Ragheb *et al.* (2000) and El-Nagar (2003).

Results presented in Table (3) also indicated that the grain yield was significantly affected by the studied sorghum varieties. It is noteworthy to mention that Shandaweel-2 hybrid was significantly superior in grain yield as compared with Dorado variety. The recorded grain yields for Shandaweel-2 hybrid and Dorado variety were (16.40 and 13.79 ard/fed), respectively. The differences between the two sorghum varieties under study could be due to their genetic variation and their response to the environmental conditions. Similar results were reported by Yousef *et al.* (1996), Latif, Sahier *et al.* (1998 and 2000), Allam *et al.* (2002) and El-Aref and Ibrahim (2004).

Regarding nitrogen fertilization the results in Table (3) showed that nitrogen levels significantly affected the grain yield. Applying 125 kg N/fed was more effective compared with other nitrogen levels whereas, the recorded grain yield was (15.83 ard/fed.). The grain yield increase per fadden under the study could be due to increases in the metabolites synthesized by plants, that may depend to a large extent upon the favourable effect of nitrogen level in the metabolic processes and physiological formation of plant organs. Moreover, the present results might be attributed to the effect of nitrogen fertilization on the vigorous vegetative growth and accumulation of photosynthesis assimilates. These results are in general harmony with those obtained by Suraked and Itnal (1997), Eweis *et al.* (1998), Latif, Saheir *et al.* (1998 and 2000). Mourad *et al.* (2000), Allam *et al.* (2002) and El-Arel and Ibrahim (2004).



The results in Table (3) indicated that the first order interaction of irrigation system X varieties was significant, whereas Shandaweel-2 hybrid surpassed Dorado variety under drip irrigation for grain yield; its grain yield was 19.38 ard/fed. The results showed that the interaction of irrigation systems X nitrogen fertilization was significant, where the nitrogen fertilization level of 125 kg N/fed under drip irrigation was significant and its grain yield was 18.48 ard/fed. The data revealed that grain yield/fed was significantly influenced by varieties X nitrogen fertilization interaction. The highest grain yield was 17.13 ard/fed when planting Shandaweel-2 hybrid and fertilized by 125 kg N/fed.

Moreover, the results indicated that grain yield was significantly affected by all interactions under study. In general, the highest value of grain yield (20.34 ard/fed.) was obtained from Shandaweel-2 hybrid that received 125 kg N/fed under drip irrigation system.

### III-N, P and K Concentrations and Protein Content of Grains:

Table (3) and Fig (1) clearly indicated that drip irrigation system had higher significant increases in N and K concentrations and protein content of grain as compared with the surface irrigation one. Absorption and translocation of nutrients in plants may be affected by the soil moisture content in soil (Abdel-Mawly, 1993 and Ragheb *et al.*, 2000).

The studied sorghum varieties had insignificant differences on N and P percentages and protein content (Table 3 and Fig 1), Shandaweel-2 hybrid surpassed Dorado variety in N and K – percentages and protein content of grain. Nitrogen and protein percentages in sorghum grains were significantly increased

with increasing nitrogen levels, while P and K – percentages were significant by varied inversely with increasing nitrogen levels. This behaviour stood in agreement with the results of Abdel-Mawly (1993) and Ragheb *et al.* (2000).

Nitrogen, P and K percentages and protein content of grains were not significantly affected by all interactions under study (Table 3). In general, the highest protein content of grains (11.21%) was obtained from Dorado variety when irrigated using the drip irrigation system and receiving 125 kg N/fed. The highest protein content of grains was obtained from Shandaweel-2 hybrid (10.35%) by receiving 125kg N/fed using the drip irrigation system. These results are in accordance with those obtained by Ragheb and El-Nagar (1997), Ragheb *et al.*, (2000) and El-Nagar (2003).

### IV-Nitrogen Recovery and N Use Efficiency:

The effect of the studied factors on N-recovery and N-use efficiencies of two sorghum varieties is shown in Table (4). A significant increase in both traits occurred as a result of the studied treatments. The use of drip irrigation system significantly increased both N-recovery and N-use efficiency of sorghum grains as compared with the surface irrigation one. These results were fully agreed with the findings of Askar *et al.* (1994) and Abdel-Mawly and El-Sharkawy (2004).

N-recovery and N-use efficiency were significantly varied by cultivars (Table 4). Highest values were obtained from Shandaweel-2 hybrid compared with those of Dorado cultivar. The increase in both traits may be due to the increase in grain yield/fed rather than the increase in protein content. These results are in an agreement with those obtained by Ragheb and El-Nagar (1997), Brogna *et al.* (2000) and



Allam *et al.*, (2002). In addition, the present results proved clearly that the application of nitrogen fertilizers to grain sorghum varieties increased nitrogen recovery, while it decreased N-use efficiencies. There was a positive relation between the level of nitrogen and N-recovery. As the level of nitrogen increased the weight of the N-recovery was increased, whereas the highest values were obtained when N levels increased up to 125 kg N/fed. This is mainly due to the increase in protein content and grain yield. The result obtained by Ragheb and El-Nagar (1997) were in line with the data in this work. Metwally and Khamis (1998) confirmed these results by indicating that the N-recovery in the grain sorghum varieties was increased with the application of chemical N-fertilizers. However, an opposite relation was found between fertilization and the N-use efficiency. The used lower N level was the better N use efficiency. Ottman and Pope (2000) indicated that N recovered from the soil possibly might be due to plant uptake and the immobilization of N in the surface soil.

All interactions under study had significant effect on nitrogen recovery and N-use efficiency (Table 4). In general, the highest value of N recovery (58.58 kg N/ fed) was obtained from Shandaweel-2 hybrid that received 125 kg N/fed under the drip irrigation system, while the highest N use efficiency (58.18%) was obtained from Shandaweel-2 hybrid that received 75 kg N/fed under the drip irrigation system.

#### V-Water Use Efficiency:

Water use efficiency expressed as a kg grains/m<sup>3</sup> water/fed as influenced by the irrigation system and N-fertilization using two sorghum varieties are shown in Table (4) and Fig. (2). Water use efficiency had higher values with the drip irrigation than with the surface

irrigation. Delivering low amount of irrigation water of 1200 m<sup>3</sup>/fed using the drip irrigation system produced the highest values of water use efficiency of 2.58 and 2.07 kg grain/m<sup>3</sup> water for Shandaweel-2 hybrid and Dorado variety, respectively. The higher water use efficiency value that obtained using drip irrigation system could be attributed to the increase in the production of biomass that was associated with keeping the available water in the root zone near to the field capacity and preventing the occurrence of soil moisture deficit, especially during the reproductive stage of growth. Similar results were obtained by Yamamoto and Cho (1982), Ragheb (1997) and Ragheb *et al.* (2000) who found that crop yield and water use efficiency were greater under the drip irrigation than under other irrigation systems. Therefore, most of the delivered irrigation water is kept into the root zone with minimum water losses.

Table (4) revealed also that water use efficiency was significantly influenced by sorghum cultivars, where its higher value was (1.89 kg grains /m<sup>3</sup> water) for Shandaueel-2 hybrid compared with value (1.57 kg grains /m<sup>3</sup> water) for Dorado variety. The increase in water use efficiency is mainly due to the increase in the grain yield.

With regards to the effect of nitrogen fertilization on water use efficiency of grain sorghum varieties the results presented in Table (4) showed that nitrogen fertilization up to 125 kg N/fed significantly improved the grain yield per unit of water applied. Thus, a minimum value (1.63 kg grains/m<sup>3</sup> water) for this trait was recorded at 75 kg N/fed. While, the maximum one (1.82 kg grains /m<sup>3</sup> water) was at 125 kg N/ fed. These results are in accordance with those obtained some other authors (Abdel-Mawly, 1993; Ragheb, 1997; Ragheb *et al.* 2002 and Abdel-Mawly and Zanouny 2005).

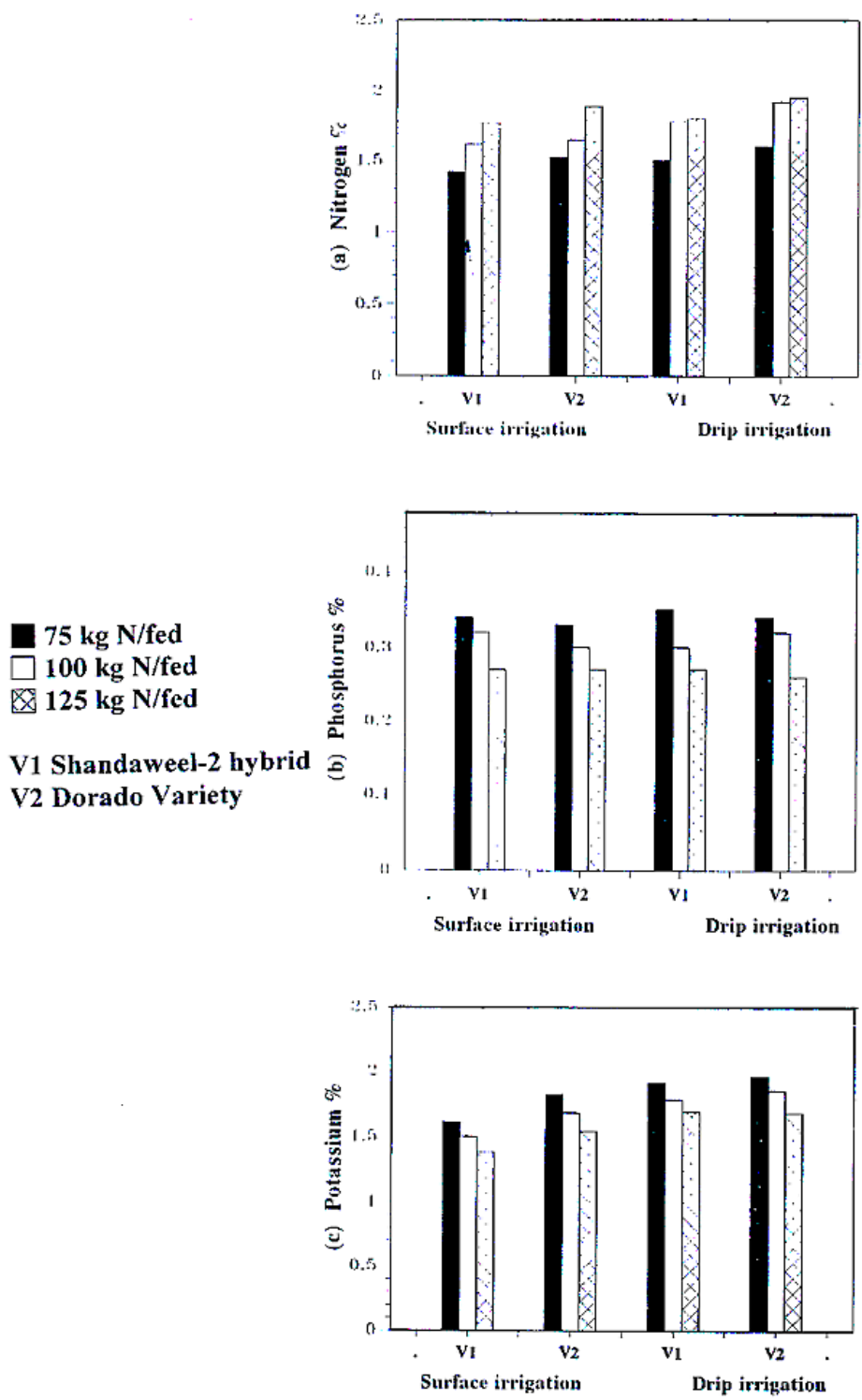


Fig. (1): Effect of irrigation system and N-fertilization level on (a) nitrogen %, (b) phosphorus % and (c) potassium of two grain sorghum varieties.

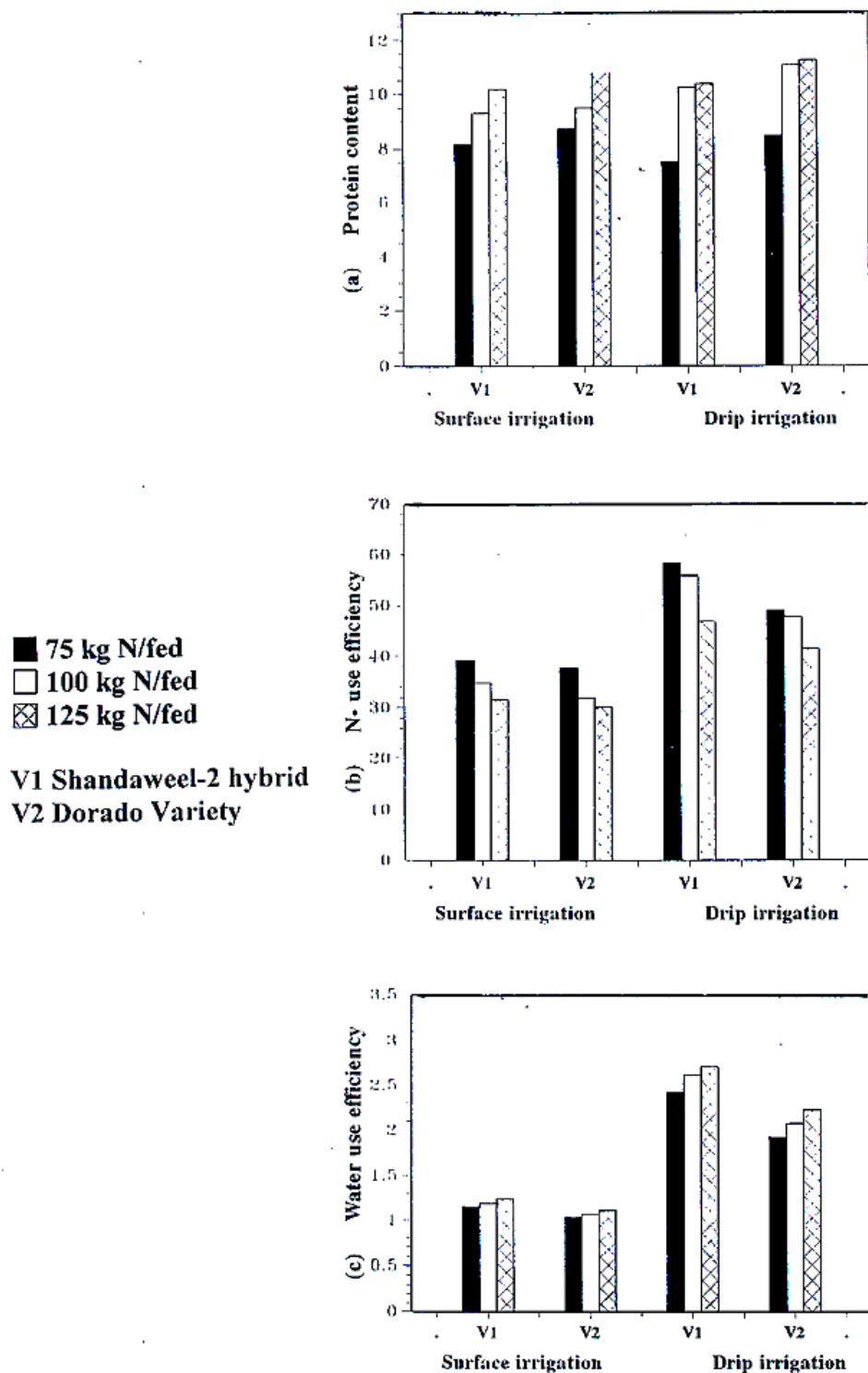


Fig. (2): Effect of irrigation system and N-fertilization level on (a) protein content, (b) N-use efficiency and (c) water use efficiency of two grain sorghum varieties.

Table (4): Effect of irrigation system and nitrogen fertilization on N-recovery (kg/fed), N-use efficiency (%) and water use efficiency (kg/m<sup>3</sup>) of two grain sorghum cultivars. (Average of 2003 / 2004 growing season)

Irrigation System (I)	N-fert. kg/fed (N)	N-recovery (kg/fed)			N-use efficiency (%)			Water use efficiency (kg/m <sup>3</sup> )		
		Varieties (V)								
		Shand-aweel-2	Dorado	Mean	Shand-aweel-2	Dorado	Mean	Shand-aweel-2	Dorado	Mean
Surface irrigation (I 1)	75	29.33	28.28	28.80	39.11	37.71	38.41	1.15	1.03	1.09
	100	34.76	31.89	33.32	34.76	31.89	33.32	1.19	1.07	1.13
	125	39.45	37.62	38.53	31.56	30.09	30.82	1.24	1.11	1.18
	Mean	34.51	32.60	33.55	35.14	33.23	34.19	1.19	1.07	1.13
Drip irrigation (I2)	75	43.63	36.81	40.22	58.18	49.08	53.63	2.42	1.92	2.17
	100	55.88	47.80	51.84	55.88	47.80	51.84	2.62	2.07	2.34
	125	58.58	51.85	55.21	46.86	41.48	44.17	2.71	2.22	2.46
	Mean	52.70	45.49	49.09	53.64	46.12	49.88	2.58	2.07	2.33
V/N	75	36.48	32.54	34.51	48.64	43.40	46.02	1.78	1.47	1.63
	100	45.32	39.84	42.58	45.32	39.84	42.58	1.91	1.57	1.74
	125	49.01	44.73	46.87	39.21	35.78	37.50	1.98	1.66	1.82
	Mean	43.60	39.04	41.32	44.39	39.67	42.03	1.89	1.57	1.73
F. Test.		I ** V **			I ** V **			I ** V **		
L.S.D.5%		N = 1.31 IV = 1.42 IN = 1.43 VN = 1.45 IVN = 2.60			N = 1.05 IV = 1.42 IN = 1.07 VN = 1.42 IVN = 1.96			N = 0.03 IV = 0.04 IN = 0.04 VN = 0.04 IVN = 0.05		

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## تحسين المحصول والكفاءة المائية لصنفين من الذرة الرفيعة باستخدام نظامى الري السطحي والتنقيط مع التسميد النيتروجيني خلف عبد المجيد العارف\*، صابر إمام عبد المولى\*\*، عبد الرحيم سيد أبو الحمد\*

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أجريت تجربة حقلية بمزرعة كلية الزراعة جامعة الأزهر بأسيوط خلال موسم النمو الصيفي ٢٠٠٣/٢٠٠٤م، وذلك لتقييم صنفين من الذرة الرفيعة هجين شندويل-٢ وصنف دورادو باستخدام الري السطحي والري بالتنقيط ومستويات من السماد النيتروجيني ٧٥، ١٠٠، ١٢٥ كجم نيتروجين/فدان. ويمكن تلخيص النتائج فيما يلي:

- ١- وجود تأثير إيجابي ومعنوي لكل من نظام الري ومستويات التسميد النيتروجيني علي المحصول ومكوناته في صنفى الذرة تحت الدراسة.
  - ٢- تم الحصول علي أعلى محصول من الحبوب (٢٠.٣٤ إردب/ فدان) من استخدام هجين شندويل-٢ مع إضافة ١٢٥ كجم نيتروجين/فدان تحت نظام الري بالتنقيط.
  - ٣- ظهور تأثير إيجابي علي تركيز النيتروجين والبوتاسيوم، وكذلك بروتين الحبوب في حين لم يظهر إي تأثير علي الفوسفور مع نظامى الري كما تأثرت كل هذه الصفات بالتسميد النيتروجيني.
  - ٤- تأثر كل من النيتروجين الممتص، وكذلك كفاءة التسميد النيتروجيني بالمعاملات المختلفة حيث كانت أفضل ما يمكن مع نظام الري بالتنقيط.
  - ٥- كانت الكفاءة الاستعمالية لماء الري عالية مع استخدام نظام الري بالتنقيط كما ازدادت بزيادة مستويات التسميد النيتروجيني المضاف.
- وبصفة عامة يمكن القول بأن هجين شندويل -٢ تفوق علي صنف دورادو باستخدام مستويات من التسميد النيتروجيني حيث كان أفضلها مع ١٢٥ كجم نيتروجين للفدان مع نظام الري بالتنقيط.