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Sugarcane responses to irrigation and nitrogen in subtropical Iran

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ABSTRACT- Limited information is available on water and nitrogen (N) management of sugarcane (*Saccharum officinarum* L.) in Khuzestan, southwestern Iran, where this crop is currently and extensively grown under heavy irrigation and N fertilization. Therefore, a field experiment was conducted from September 2000 to March 2002 at the Research Department of Karoon Agro-industry in Khuzestan to determine the effect of four irrigation [irrigation water/cumulative pan evaporation (IW/CPE) ratios of 0.6, 0.8, 1.0, and 1.2)] and four N (0, 86, 172, and 258 kg N ha^{-1}) levels on sugarcane yield and water and N use efficiencies. The experiment was carried out as split-plot arranged in a randomized complete blocks design with four replications. Pan evaporation data was recorded daily using class A open pan. Increased water and N application increased both plant cane crop and sugar yields. The highest sugar yield was obtained under IW/CPE = 1.2 (29 irrigations) and with 172 kg N ha^{-1} with no significant difference with IW/CPE = 1.0 (25 irrigations) and 86 kg N ha^{-1}, respectively. Higher irrigation and N levels showed a small but not significant reduction in both juice sucrose and purity percentages. Higher N levels significantly increased the N use efficiency (NUE) for cane yield, but NUE for sugar yield was highest at 86 kg N ha^{-1}. Water use efficiency (WUE) increased with higher water application. Thus pan evaporation data and N management can effectively meet both irrigation (IW/CPE = 1.0) and N requirements (86.0 kg ha^{-1}) of sugarcane without any adverse effect on yields and environment and reduces production costs as well.

Keywords: Juice purity, Juice sucrose, NUE , Sugarcane yield, Sugar yield, WUE

INTRODUCTION

Sugarcane is a C_4, high biomass crop which requires large amounts of water for maximum production. Irrigation of sugarcane can increase cane yields, enable more ratoons to be grown and improve crop longevity. However, excess water impede aeration due to water logging, causing yield reduction and also water losses (6, 25). In contrast, deficit irrigation results in crop wilting, pith formation and ultimately

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yield reduction (17). Therefore, the main objective of water management is to estimate crop water requirements and optimize WUE for limited water supply.

Sugarcane growth in Khuzestan in southwest Iran with high solar radiation is highly depended on irrigation water (28). Being a long duration crop and because of its low irrigation efficiency in the region, the applied irrigation water for normal growth is 3000 mm with peak water use of 10 to 13 mm d^{-1} during the grand growth period (12). Irrigation development in the region will largely depend on water resource development, water pricing policy and other factors affecting profitability. With ample low priced water, little attention is paid to water management of the crop for maximizing efficiency (26). Concern over water for irrigation is mounting in the region where water supplies are limited and communities are becoming more conscious of the impact of irrigation on the environment.

Sugarcane also shows high response to N application. It can utilize 4 to 7 kg N ha^{-1} per day during its rapid growth period (4, 6). Substantial amounts of N fertilizer is necessary for commercial sugarcane production due to large biomass produced by the crop. However, as harvest time approaches it is desirable to have much of the soil N depleted (5). In addition, juice quality may be reduced by excess N application (15, 20). The total amounts of N fertilizer which are used for plant cane production in Khuzestan is 400 kg ha^{-1} of urea and 400 kg of diammonium phosphate annually (13).

Considering the rising cost of both water for irrigation and N fertilizers and possible environmental pollution in Khuzestan, Iran, where sugarcane is extensively grown, it is necessary to determine irrigation and N requirements of the crop without adversely affecting cane and sugar yields. The purpose of this study was to determine the influence of water and N management on yield, NUE and WUE of sugarcane plant crop in Khuzestan, Iran.

MATERIALS AND METHODS

A field experiment was carried out in the Agricultural Research Department of Karoon Agro-industry at Khuzestan province (32° 5′ N, 48° 43′ E, alt., 60 m), in southwestern Iran from September 2000 to March 2002. The region represents semi-arid and subtropical climatic conditions with very hot summers and fairly cool winters (Fig. 1). There is no rainfall during the main growing period (May-October) for sugarcane, and the rainfall seasons usually run from early November to early March when no crop growth occurs due to fairly cool weather. Average solar radiation is 18.6 MJ m^{-2} d^{-1} peaking at 27.0 MJ m^{-2} d^{-1} in June (28). The soil is a silty clay loam with pH, EC, and total N contents of 8.3, 1.5 dS m^{-1}, and 0.065 %, respectively (16).

The experiment was conducted as split-plot arranged in randomized complete block design with four replications. Treatments consisted of four irrigation levels (IW/CPE ratios of 0.6, 0.8, 1.0, and 1.2) were used in main plots and four N levels (0, 86, 172, and 258 kg N ha^{-1}) were used as subplots. Irrigation was scheduled using a meteorological approach based upon IW/CPE ratio, where IW refers to irrigation water in terms of depth, and CPE is the cumulative pan evaporation which was measured as the sum of daily evaporation from standard US Weather Bureau open pan. Irrigation was scheduled to attain the predetermined values of CPE. The Irrigation treatments were applied when pan evaporation values reached levels of 92, 110, 138 and 183 mm for IW/CPE ratios of 1.2, 1.0, 0.8, and 0.6, and total irrigation numbers were 29, 25, 21, and 19, respectively for a constant irrigation depth of 110 mm for all ratios. Pan evaporation data have been found to be acceptable for water application compared to Thornwaite, Blaney and Criddle, or Penman methods for sugarcane (1, 30, 33). Plots were furrow irrigated with open ditches and siphons. No crop lodging occurred at any irrigation levels. The study area had a drainage system, however, two observation wells were installed to a 3 m depth in the field site to monitor the water table depth, which was always below 2.5 m.

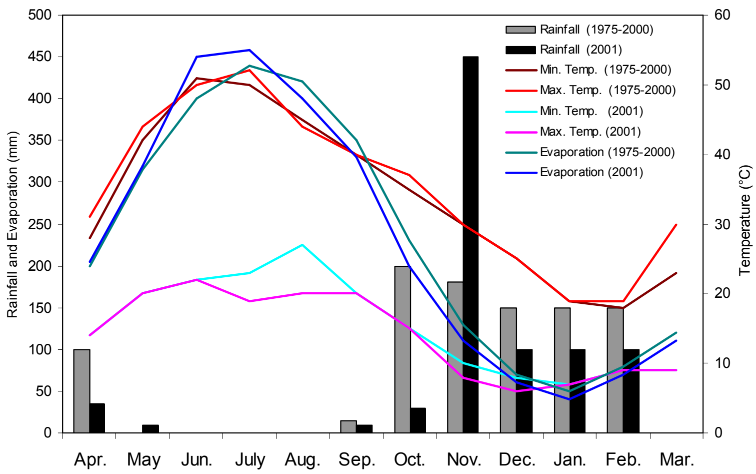

Fig. 1. Mean of 25 years of monthly minimum and maximum temperature, total evaporation (mm) and rainfall values (mn) at Agric. Res. Center, Karoon Agro-industry, Khuzestan, Iran (the growth period of sugarcane is from April. to October

All N treatments were applied as top-dressing just before plot irrigation at three times, 20% on early April, 40% on late May, and 40% on early July 2001. Triple superphosphate fertilizer (25 kg ha^{-1}) was uniformly applied at planting time.

Land preparation consisted of deep subsoiling (90 cm), disking, planting and furrowing, respectively. Each subplot had six cane rows 3 m long and 1.5 m wide. The seed of cane pieces were about 50 cm long with 3 to 4 nodes and were hand planted on September 11, 2000. Plot weeding was done by hand three times during the experiment. The commercial sugarcane cultivar was CP48-103, a tall mid-maturity cane, originally selected from breeding lines in Florida and it has been used in the region since 1965. No pest control were applied and no nutrient deficiency symptoms were observed on the plants during the experiment.

Sugarcane growth starts in the region in the spring in early April and continues through early November when cool temperatures stop further growth, and the rapid growth period starts at the stem elongation stage and peaks at the hottest months (July-August) (Fig. 1). All plots were irrigated at potential evapotranspitration (ET) till early April (tiller intitiation growth stage) when rapid crop growth period began. Then they were irrigated according to their treatment schedules for six months starting from early April and stopped in mid October 2001 for crop ripening.

The crop was burned at harvest time, stalks were cut at soil surface, the tops were removed and stalk fresh weight was measured. The central two rows of each subplot were used for final harvest. A random-20 stalks sample was taken from each plot and crashed using a hydraulic rolling mill. Juice was analyzed for Brix (total soluble solids) using a refractometer (Bausch and Lomb Inc., Rochester, NY) and sucrose concentration (POL) using polarimeters (Schmidt and Haensch, Germany). Cane sucrose content was calculated using formula developed from sucrose and temperature Brix concentration tables (14).

$$S = \frac{\mathrm{POL} \times 26}{105.81 + 0.044(\mathrm{B} - 15)} \qquad (1)$$

Where the 20° C temperature correction for Brix is

$$B + 0.075(T - 20) \qquad (2)$$

Purity of cane juice was determined by the formula:

$$P = \frac{S \times 100}{B} \qquad (3)$$

Where T, P, S and B are temperature (° C), purity (%), sucrose (%) and Brix (%), respectively

Water use efficiency was determined by dividing the stalk or sugar weight by the total amount of irrigation water applied. Nitrogen use efficiency was determined by subtracting cane or sugar weight of each treatment from unfertilized (control), then dividing by nitrogen rate applied. Soil moisture contents at 0-33, 33-66 and 66-100 cm depths were determined using the gravimetric method at planting, before and after each irrigation. The data were analyzed statistically using SAS method (22), and means were compared by the least significant difference (LSD) test.

RESULTS AND DISCUSSION

The amount of crop water use was generally low during the early growth stage (winter and early spring) and the available soil moisture at 0 to 33 cm depth seemed to be adequate for early crop growth before the onset of the grand growth period (stem elongation stage, about mid April) in the region.

Sugarcane crop plants are typically the highest yielding and the yield decline with crop age. Plant cane yield in this study highly responded to the total amount of water applied with the highest cane yield (155.4 Mg ha^{-1}) obtained at the highest irrigation level (IW/CPE = 1.2, i.e. 29 irrigations) (Table 1). These results are consistent with Wiedenfeld (31) and Wiedenfeld (33) who found a pronounced yield increase of cane with increasing irrigation levels, however, Wiedenfeld and Enciso (34) reported no significant differences in cane or sugar yields with increased water application. The reason for the lack of difference in the later study was the smaller differences in irrigation levels. Lower irrigation levels significantly decreased yield, and the crop suffered the desiccating effect of high July-August-September temperatures (Fig. 1) under water stress (IW/CPE = 0.8 and 0.6). Juice purity was the highest under IW/CPE = 1.2 (Table 1) and decreased with increased irrigation level, as found in subtropical region (24). Higher irrigation levels caused more vegetative growth which resulted in dehydration and forced the conversion of total sugars to convertible sucrose and used them for growth compared to lower irrigation levels (3). However, very low irrigation level (0.6 ratio) reduced the sucrose content during the ripening period which agrees with the results of Prasad *et al* (18). Inman-Bamber *et al*. (8) also showed higher sucrose content of sugarcane in dry compared to wet treatments. Sugar yield was highest (15.9 Mg ha^{-1}) under IW/CPE = 1.2 with no significant difference with IW/CPE = 1.0. More water applied under the IW/CPE = 1.2 treatment did not bring about any advantage to sugar yield.

Table 1. Effect of irrigation and nitrogen levels on sugarcane yield and sugar quality

Treatment	Cane yield (Mg ha^{-1})	Juice sucrose (%)	Sugar yield (Mg ha^{-1})	Juice purity (%)
Irrigation level (IW/CPE)				
0.6 (19 irrigations)	76.8	17.6	8.2	88.9
0.8 (21 irrigations)	107.5	17.3	11.2	88.2
1.0 (25 irrigations)	149.3	17.3	15.6	88.5
1.2 (29 irrigations)	155.4	16.7	15.9	89.0
LSD* (0.05)	4.8	0.6	0.6	0.7
N level (kg ha^{-1})				
0	105.9	17.7	11.4	88.0
86	128.3	17.5	13.4	88.0
172	133.1	17.2	13.4	87.9
258	121.7	17.4	12.4	87.9
LSD* (0.05)	21.0	1.5	2.0	2.2
Significant levels				
N	*	NS	*	NS
Irrigation	**	NS	**	NS
N × Irrigation	NS	NS	*	NS

***LSD = Least Significant Difference*, ** and NS, significant at 0.05, 0.01 probability level and non-significant, respectively**

Initial soil N contents in spring 2001 showed low levels of total N and no salinity problem, which is typical for the soils of the region. The sugarcane crop responded to increased N fertilizer application rate as both cane and sugar yields increased up to 172 kg N ha^{-1} (133.1 and 13.4 Mg ha^{-1}, respectively), but decreased afterward at 258 kg N ha^{-1} with no significant difference with 86.0 kg ha^{-1} (Table 1). Increased yield is attributed to higher crop growth and more efficient use of N. Sing and Mohan (23) reported significant effects of applied N up to 200 kg ha^{-1} on yield in a subtropical region, however, Rozeff (21), Wiedenfeld (32) and Wiedenfeld and Enciso (34) found neither significant effect of N levels on cane and sugar yields nor sucrose concentration in the plant cane crop. Nitrogen fertilizer rates had no significant effects on either sucrose content or purity (Table 1), however, higher N rates reduced the juice purity which is in agreement with results obtained from other studies (15, 29, 34). Higher N levels coupled with adequate water and higher temperatures of the region (Fig. 1), probably caused more vegetative growth which resulted in the conversion of sucrose to simple sugars and used them for growth compared with lower N rates (19, 20).

NUE for cane yield was highest (158.1 kg kg^{-1}) at 172 kg N ha^{-1},but decreased afterward as N level was increased. However, sugar yield decreased as N application level increased (Table 2). Isa *et al*. (9) also showed a high N recovery (>90%) from urea in sugarcane growing in nonsaline soil in Tanzania. Higher N levels significantly increased the NUE for cane yield, but NUE for sugar yield was the highest (23.2 kg kg^{-1}) at 86 kg N ha^{-1} indicating the higher crop growth and more efficient use of N. All of this would suggest that plant crop yield showed good response to N application (86 kg N ha^{-1}) in subtropical Iran.

There was not a highly significant interaction between N fertilizer and irrigation levels on sugar yield, which is contradictory with Stanley *et al*. (27) and Wiedenfeld (31) who found pronounced effect of N fertilizer on irrigated sugar yield. The yield difference between N rates at IW/CPE = 0.6 can probably be attributed to high N levels which might have slowed down the crop growth rate and reduced the yield. As water stress increases, sugarcane response to N fertilizer, generally decreases (31, 32). Sucrose content, generally varied inversely with yields during the growth period due to favorable conditions for crop growth (2).

Table 2. Total water applied to sugarcane during the growth period*, WUE and NUE of cane and sugar yields under different irrigation and nitrogen levels*

Treatment	Water application (mm)	WUE of cane (kg m^{-3})	WUE of sugar (kg m^{-3})
Irrigation level (IW/CPE)			
0.6 (19 irrigations)	3.67	3.67	0.39
0.8 (21 irrigations)	4.65	4.65	0.48
1.0 (25 irrigations)	5.43	5.43	0.57
1.2 (29 irrigations)	4.87	4.87	0.50
LSD* (0.05)	-	0.66	0.09
N rates (kg ha^{-1})		**NUE of cane (kg kg^{-1})**	**NUE of sugar) (kg kg^{-1})**
0	-	-	-
86	-	26.0	23.2
172	-	158.1	11.6
258	-	61.2	3.8
LSD* (0.05)	-	34.0	8.4

***The data are for during the crop growth period and before the onset of seasonal rainfall in 2001.**
***LSD = Least Significant Difference**

Total water use, which is the sum of soil profile water contribution before the onset of rainfall in 2001 and irrigations during the crop growth period increased with increase in IW/CPE ratios and the maximum water (3190 mm) was applied at IW/CPE = 1.2 (Table 2). Water use efficiency is a function of crop yield and total water use, and is affected by weather conditions and crop age. In this experiment, WUE increased with increasing IW/CPE = 1.0 for cane (5.43 kg m^{-3}) and for sugar (0.57 kg m^{-3}) yields and decreased thereafter at IW/CPE = 1.2. Water use efficiency therefore was the highest where cane and sugar yields were highest. More water applied under the IW/CPE = 1.2 did not give any advantage to the crop. These findings are similar to Sing *et al*. (24), and Wiedenfeld and Enciso (34) who reported increased cane yield with higher water application in plant crop. However, in Wiedenfeld and Enciso (34) study, WUE declined with increasing water application level since yields did not significantly increased with increased water application every year. These WUE values are below the generally accepted rule of thumb that 1 cm of water will produce 1 Mg ha^{-1} of cane (11). While Jones (10) reported cane yield vary from 180 to 304 Mg ha^{-1} for total water use of 2500 mm in Hawaiia, Sing *et al*. (24), and Wiedenfeld and Enciso (34) found WUE for cane of 71 kg mm^{-1} in subtropical India, and 7.2 Mg ml^{-1} for plant crop in south Texas, respectively.

Measurement of soil water content in the soil profile during crop growth showed that there was adequate soil water for crop growth early in the season giving a lower water requirement - because of winter rainfall and lower ET (Table 3 and Fig. 1). In addition, water deficits for crop growth were greater under IW/CPE = 0.8 and 0.6, particularly during July through August indicating the need for water application (Table 3). Reduced irrigation at the tillering stage (up to mid May) thus can save water and increase WUE due to much lower ET, but the crop is highly responsive to water stress after the stem elongation stage (rapid growth period) (32). Irrigation thus can be used more sparingly since biomass accumulation (7), e.g. moderate deficit irrigation (up to IW/CPE = 0.8) during the tillering stage (24) and high irrigation level (IW/CPE = 1.2) at the yield formation stage with relatively high N application can provide the highest WUE and would increase yield. If such options are implemented, sugarcane production costs could be lowered and water loss to the environment through evaporation, runoff, and drainage could be minimized.

Table 3. Soil water content (%) through 0-66 cm soil profile during sugarcane rapid growth period

Irrigation level (IW/CPE)	Sampling time	
	Just before irrigation	48 h. after irrigation
0.6	13.8	20.1
0.8	14.6	20.2
1.0	16.1	20.3
1.2	15.9	20.3

CONCLUSIONS

In this study, growth and yield responded primarily to the total amount of water applied. Both cane and sugar yields significantly increased with increased water and N application levels. The highest sugar yield was obtained under IW/CPE = 1.2 (29 irrigations) and with 172 kg N ha^{-1} with no significant difference with IW/CPE = 1.0 (25 irrigations) and 86 kg N ha^{-1}, respectively. Higher irrigation and N levels showed a small but not significant reduction in both juice sucrose and purity percentages. Higher N rates significantly increased the NUE for cane yield, but NUE for sugar yield was the highest at 86 kg N ha^{-1}. Water use efficiency was higher where cane and sugar yields were higher. Thus, irrigation scheduling based upon open pan evaporation (IW/CPE = 1.0) and N fertilization (86.0 kg N ha^{-1}) can estimate the irrigation and N requirements of the sugarcane crop without unfavorable effects on yields and environment. Further refinement of these findings will require additional work to address responses of treatments to ratoon crops.

REFERENCES

1. Azizi-Zohan, A. A. Kamgar-Haghighi, A. R. Sepaskhah. 2008. Crop and pan coefficients for saffron in a semi-arid region of Iran. J. Arid Environ. 72: 270-278.

2. Carter, C. E., J. M. Floyd. 1973. Subsurface irrigation and drainage for sugarcane. Transactions of the ASAE. 16: 279-281.

3. Dorenboss, J., A. H. Kassam. 1979. Yield response to water irrigation and drainage, Paper 33. F.A.O., Rome. 145p.

4. Gascho, G. J., D. L., Anderson, and, H. Y. Ozaki. 1986. Cultivar dependent sugarcane response to nitrogen. Agron. J. 78: 1064-1069.

5. Hauck, R. D. 1984. Nitrogen in crop production. Amer. Soc. Agron., Inc., Wisconsin, USA. 804p.

6. Ingram, K. T., and H. W. Hilton. 1986. Nitrogen-potassium fertilization and soil moisture effects on growth and development of drip–irrigated sugarcane. Crop Sci. 26: 1034-1039.

7. Inman-Bamber, N.G. 2004. Sugarcane water stress criteria for irrigation and drying off. Field Crops Res. 89: 107-122.

8. Inman-Bamber, N.G., G. D. Bonnet, M. F. Spillman, M. L. Hewitt, and J. Jackson. 2008. Increasing sucrose accumulation in sugarcane by manipulating leaf extension and photosynthesis with irrigation. Aust. J. Agric. Res. 59: 13–26.

9. Isa, D. W., G. Hoofman, and O. V. Cleemput. 2006. Uptake and balance of fertilizer nitrogen applied to sugarcane. Field Crops Res. 95: 348-354.

10. Jones, C. A. 1980. A preview of evapotranspiration studies in irrigated sugarcane in Hawaii. Hawaian Planter, s Rec. 59: 195-214.

11. Jones, C. A., L. T. Santo, G. Kingston, G. J. Gascho. 1990. Sugarcane. In B. A. Steward, D. R. Nielson (Eds). Irrigation of agricultural crops. Agronomy Monograph No. 30. Amer. Soc. Agron., Inc., Wisconsin, USA.

12. Karab Consulting Engineers. 1992. Reports of water requirement and irrigation schedules for sugarcane planting in Khuzestan. Karoon Agro-industry, Khuzestan, Iran. 50 p. (In Farsi).

13. Koochekizadeh, A., G. Fahi, M. H. Gharineh, S. A. Siadat, S. Jafari, and Kh.Alami-Saeid. 2009. Impacts of rate and split application of N fertilizer on sugarcane quality. Inter. J. Agric. Res. 4: 116-123.

14. Meade, G. P., and C. P. Chen. 1977. Cane Sugar Handbook. 10th Ed. Willey, N.Y., 947p.

15. Muchow, R. C., M. J. Robertson, A. W. Wood, and B. A. Keating. 1996. Effect of nitrogen on the time–course of sucrose accumulation in sugarcane. Field Crops Res. 47: 143-153.

16. Page, A. L., R. H. Miller, D. R. and D. R. Keney. 1982. Methods of soil analysis. Part 2, 2nd Edition, Amer. Soc. Agron., Madison, Wisconsin., USA.

17. Parihar, S. S., B. S. Sandhu, and Sing, N. T. 1975. A critical appraisal of research on irrigation scheduling of crops. Proc. 2nd World Cong. on Water Resource, IWRA, New Delhii, 1: 343-349.

18. Prasad, U. K., B. K. Verma, and T. N. Prasad. 1990. Effect of irrigation and nitrogen on sugarcane (*Saccharum officinarum* L.) and sugar yield, water use efficiency, soil moisture depletion and nitrogen uptake in calcareous soil. Ind. J. Agric. Sci. 60: 396-401.

19. Rana, N. S., and N. K. Saini. 1989. Effect of nitrogen fertilization on juice quality of sugarcane. Ind. J. Agron. 34: 259-260.

20. Robertson, M. J., R. C. Muchow, A. W. Wood, and J. A. Campbell. 1996. Accumulation of reducing sugars by effects of crop age, nitrogen supply and cultivar. Field Crops Res. 49: 39-50.

21. Rozeff, N. 1990. A survey of south Texas sugarcane nutrient studies and current fertilizer recommendations from this survey. J. Amer. Soc. Sugarcane Technol. 10: 26-33.

22. SAS Institute, 2000. SAS user' s guide, SAS Inst., Cary, NC., USA.

23. Sing, P. N., and S. C. Mohan. 1994. Water use and yield response of sugarcane under different irrigation schedules and nitrogen levels in asubtropical region. Agric. Water Mange. 26: 253-264.

24. Sing, P. N., S. K. Shukla, and V. K. Bhatnagar. 2007. Optimizing soil moisture regime to increase water use efficiency of sugarcane (*Saccharum* spp complex) in subtropical India. Agric. Water Mange. 90: 95-100.

25. Solomon, S., H. N. Shahi, A. P. Gupta, G. P. Rao, and B. L. Srivastava. 2000. Cane Sugar: Production Management. Intern. Book Dist. Co. Lucknow, India. 474 p.

26. Soopramanien, G.C., B. Berthelot, and C. H. Batchelor. 1990. Irrigation research, development and practice in Mauritius. Agric. Water Manage. 17: 129-139.

27. Stanley, C. D., R. E. Green, M. A. Khem, and L. T. Santo. 1990. Nitrogen fertilizer rate and soil nitrate distribution for microirrigated sugarcane. Soil Sci. Soc. Amer. J. 54: 217-222.

28. Sund, A.K., and H. F. Clements. 1974. Production of sugarcane under saline desert conditions in Iran. Hawaii Agric. Exp. Sta. Res. Bull. 67p.

29. Thomas, J. R., A. W. Scott, R. P. Widenfeld. 1985. Fertilizer requirement of sugarcane in Texas. J. Amer. Soc. Sugarcane Technol. 4: 62-72.

30. Torres, J. S. 1998. A simple visual aid for sugarcane irrigation scheduling. Agric. Water Manage. 37: 77-83.

31. Wiedenfeld, R. P. 1995. Effects of irrigation and N fertilizer application on sugarcane yield and quality. Field Crops Res. 43: 101-108.

32. Wiedenfeld, R. P. 2000. Water stress during sugarcane growth periods on yield and response to N fertilization. Agric. Water Manage. 43:173-182.

33. Wiedenfeld, B. 2004. Scheduling water application on drip irrigated sugarcane. Agric. Water Manage. 64: 169-181.

34. Wiedenfeld, B., and J. Enciso. 2008. Sugarcane response to irrigation and nitrogen in semiarid south Texas. Agron. J. 100: 665-671.

واکنش نیشکر به آبیاری و کود نیتروژن در شرایط نیمه گرمسیری ایران

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چکیده - در حال حاضر نیشکر (*Saccharum officinarum* L.) در خوزستان اغلب در شرایط آبیاری سنگین و کود زیاد نیتروژن کشت و کار می‌شود و اطلاعات محدودی در این باره وجود دارد. لذا به منظور بررسی تاثیر چهار میزان آبیاری (نسبت‌های میزان آبیاری به تبخیر تجمعی تشتک (IW/CPE) ۰/۶، ۰/۸، ۱/۰ و ۱/۲) و چهار میزان نیتروژن (صفر، ۸۶، ۱۷۲ و ۲۵۸ کیلوگرم نیتروژن خالص در هکتار) روی عملکرد نیشکر و کارآیی مصرف آب و نیتروژن، آزمایشی در مرکز تحقیقات نیشکر شرکت کشت و صنعت کارون انجام شد. طرح آزمایشی به صورت کرت‌های خرد شده در قالب بلوک‌های کاملا تصادفی با چهار تکرار بود. آمار تبخیر از سطح آزاد تشتک کلاس A به صورت روزانه گزارش گردید. با افزایش میزان آبیاری و کود نیتروژن هم مقادیر نی و هم شکر افزایش یافت و بیشترین عملکرد در شرایط IW/CPE =۱/۲ (۲۹ آبیاری) و ۱۷۲ کیلوگرم در هر هکتار نیتروژن به دست آمد که با نسبت IW/CPE =۱/۰ (۲۵آبیاری) و ۲۵۸کیلوگرم نیتروژن در هکتار تفاوت معنی‌داری نداشت. مقادیر بیشتر آبیاری و کود نیتروژن هم درصد ساکاروز و هم درصد خلوص شربت را کاهش دادند، ولی تفاوت آنها معنی‌دار نبودند. مقادیر بالاتر کود نیتروژن به صورت معنی‌داری کارآیی مصرف نیتروژن را در عملکرد نی افزایش، ولی در عملکرد شکر کاهش دادند و بیشترین عملکرد شکر در ۸۶ کیلوگرم نیتروژن در هکتار به دست آمد. کارآیی مصرف آب با کاربرد بیشتر آب افزایش یافت. بنابراین با استفاده از اطلاعات مربوط به تبخیر ازسطح آزاد تشتک و مدیریت کود نیتروژن می‌توان به صورت کارآیی هم میزان آبیاری (IW/CPE =۱/۰) و هم میزان کود نیتروژن (۸۶ کیلوگرم در هکتار) را در نیشکر تعیین کرد، بدون این که اثرات سویی بر عملکرد و محیط زیست داشته باشد و همین طور، هزینه‌های تولید را نیز کاهش داد.

واژه های کلیدی: خلوص شربت، ساکاروز شربت، عملکرد نیشکر، عملکرد شکر، کارایی مصرف آب، کارایی مصرف نیتروژن

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