Plant Archives Vol. 19, Supplement 1, 2019 pp. 1373-1377 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF CUTTING PERIODS ON THE CONCENTRATION OF HYDROCYANIC ACID FOR FIVE CULTIVARS OF SORGHUM (*SORGHUM BICOLOR* L.)

Ali Salim Hussein and Hussein Razzaq Nayyef
Shatra Technical Institute, Southern Technical University, ThiQar Governorate, 64007, Iraq.

Abstract

An experiment was conducted in the fields of the technical institute, Al-Shatrah during the autumn and spring seasons of 2015-2016 to determine the concentration and the pathway of the hydrocyanic acid during the growth stages in different parts of the sorghumplant. Five cultivars of sorghum (Pioneer-985, G-251, Bravo-M, Topaz, and local cultivars) were used as main treatments. Five cutting periods (25, 35, 45, 55, 65 days) were used after cultivation as sub-treatments. The split-plot system was used in the Randomized Complete Block Design (RCBD), with four replicates. The study showed that Bravo-M was their content of hydrocyanic acid less than the rest of the other cultivars, which did not differ significantly from the local cultivars, for the two autumn seasons, 2015 and spring 2016, and for all parts of the plant (leaves and stems) (whole plant).The study also showed that the concentration of hydrocyanic acid in the leaves was higher compared to other parts of plants. The results of the study showed that the period of cutting after 35 days of cultivating was significantly excelled on the other periods in terms of their content of acid in both leaves and stems and for both autumn and spring seasons. As for the whole plant, the cutting period after 45 days of cultivating was excelled on the other cutting period and did not differ significantly from the cutting period after 35 days of cultivating, The cutting period after 65 days gave the lowest content of hydrocyanic acid and did not differ significantly from the cutting period after 55 days of cultivating and for both autumn and spring seasons 2015-2016.

Keywords : Pioneer-985, G-251, Bravo-M, Topaz and local cultivars.

Introduction

Sorghum (*Sorghum bicolor* L.) is considered an annual summer crop with high nutritional value, it can be used in various methods, where It is used as a solling, hay or silage (Al-Tikriti *et al*., 1997), it is widely cultivated in dry, semi-dry and tropical areas, it is highly tolerant of drought (Radwan Al-Fakhri, 1985).The stages of the cutting of sorghum are the most important factors affecting the composition of hydrocyanic acid with toxic effect on farm animals, which leads to poisoning at the green feeding, especially in the first phases of the plant life and their percentage decreases as the plant progress in age (2009 Gorashi), The toxicity results from the formation of hydrocyanic acid (HCN) naturally in the plant in the form of Dhurin in different parts of the plant (Leaves, stems and inflorescence). These compounds are transformed into the animal's stomach for (HCN) and directly affect hemoglobin (Al-Takriti *et al*., 1997). Miller and Mobee (2008) indicated to that there is a significant effect of the age of the plant on the concentration of hydrocyanic acid since the percentage of formation of this acid in the plant depends on many factors, including nitrogen fertilization, plant age, water stress and other factors. Eck, (2009) found in a study of nine cultivars of hybrid grain Sorghum that the average leaf content of hydrocyanic acid was higher compared to other parts of the plant (stems and inflorescence).Petil and Umrain, (2009) found that the Sorghum content of the hydrocyanic differed by the different cutting stages and noted that the concentration of this acid was higher in the early stages of plant life and had less content at the Dough Ripe Stage for the grains. Hamad (1996) found that there were significant differences in the concentration of hydrocyanic acid at the different cutting stages and the highest concentration at cutting after 30 days of cultivating and the lowest concentration at cutting after 50 days of cultivating. Watkin and Thom, (2010) noted that there was a significant effect for the cutting periods in the concentration of hydrocyanic acid, where this percentage increased in the early stages of plant life and the highest concentration was after 35 days of cultivating compared to other periods of 60,50 days after cultivating, so it is clear that the amount of acid varies with different parts of the plant and cutting periods, This study aims to determine the concentration and pathway of the hydrocyanic acid in the parts of the Sorghum plant during the different stages of plant growth because it is important in determining grazing periods and in the crop for the purpose of using it as green feed and avoiding poisoning. The study aims to give an indication of the best-cultivated cultivars within this study for their content of hydrocyanic acid.

Materials and Methods

A fields experiment was conducted during the autumn and spring seasons of 2015-2016 in the field of the technical institute, Al-Shatrah to determine the concentration and the pathway of the hydrocyanic acid during the growth stages in different parts of the sorghum. The cultivating was conducted on clay loam soil, Table (1) shows the physical and chemical properties of the soil of the experiment. The split-plot system was used in the Randomized Complete Block Design (RCBD), with four replicates. Five cultivars of sorghum (Pioneer-985, G-251, Bravo-M, Topaz and local cultivars) were used as main treatments. Five cutting periods (25, 35, 45, 55, 65 days) were used after cultivation as sub-treatments. The soil was plowed with two orthogonal planks, which were cleaned and settled and divided into (3 m × 5 m^2). The seeds were cultivated on lines 50 cm between one line and another (Al-Tikriti *et al*., 1997). The seeds were cultivated in the form of a line on 17/7/2015 for the autumn season and 7/4/2016 for the spring season (Al-ghalibi, 1998). Nitrogen fertilizer was added at a rate of (120 $kg.ha^{-1}$) nitrogen in the form of urea fertilizer (46% N) in three batches during the growth stages (the first batch before cultivating, which mixed with soil, the second batch during the branches stage and the third batch at the beginning of the flowering. The concentration of hydrocyanic acid was estimated for each of the leaves, stems and whole plant (as a whole).Ten samples were randomly selected from each experimental unit according to the cutting period, where cut into small parts according to the method of (Kins *et al*., 2004) using a Spectrophoto Meter on a wave of 330 nm to estimate the hydrocyanic acid according to (Groz *et al*., 1998) using the following equation.

The concentration of hydrocyanic acid Ppm

$$(HCN) = \frac{330 \times (DF) \times (VE)}{Frwt \times 27.9} \times 27.03$$

where:

DF: The probe constant is used to achieve the modified model for measurement

VE: volume of Distilled water (ml) used to extract plant tissue

Frwt: The fresh weight of the extracted tissue per g

Statistical analysis of the data was conducted by using variance analysis for each season separately and using the least significant difference. S.D. to compare the averages of treatments at a significant level (0, 05) (Torriest, 1980).

Table 1: Chemical and Physical Analysis of Experiment Soil for Autumn and Spring Season 2015.

Traits	Autumn Season 2015	Spring Season 2016
PH	14.7	8.7
Electrical conductivity EC	11.5	13.5
Organic matter	92.1	84.1
Nitrogen	165.0	162.0
Phosphorus	Ppm15.162	Ppm156
Potassium	$mg.g^{-1}$ soil 052.1	$mg.g^{-1}$ soil044.1
Sand	$mg.g^{-1}$ soil 281	$mg.g^{-1}$ soil 282
Silt	$mg.g^{-1}$ soil 4.386	$mg.g^{-1}$ soil 3.385
Clay	$mg.g^{-1}$ soil 6.332	$mg.g^{-1}$ soil 7.332

Results and Discussion

First: concentration of the hydrocyanic acid in the stem

Tables (2, 3) show significant differences in the concentration of hydrocyanic acid in the stems due to the effect of the cultivars, the cutting periods and the interaction between them for both seasons (2015-2016), where the Pioneer-985 cultivar was significantly excelled on the other cultivars by giving it the highest concentration of hydrocyanic acid in the stems amounted to (518.6, 575.5 Ppm) for the both seasons (2015-2016), respectively, achieving a relative increase amounted to (44.69%, 51.20%) compared to Bravo-M cultivar, which gave the lowest concentration of hydrocyanic acid for the seasons 2016, 2015, respectively. In the same vein, there was no significant difference between the local cultivar and the BRAVO-M cultivar, which gave the lowest concentration of hydrocyanic acid for the season 2016 only, while the cutting periods also had a significant effect on the concentration of hydrocyanic acid and both seasons (2015-2016), where the excelling of the cutting period 35 days after cultivating was significantly affected over other periods by giving it the highest concentration amounted to (539.9-594.7 Ppm) for the period (2015-2016), respectively, while the cutting period of (65) days after cultivating gave the lowest average amounted to (279.8-243.5 Ppm) for the years 2015-2016, respectively, with a percentage of decrease amounted to (52.9%, 54.9%) for the two seasons 2015 -2016 compared to the cutting period (35) days after cultivating. There was also a significant interaction between the cultivar and the cutting periods where the Pioneer-985 cultivar was excelled on the cutting period (35) days after cultivating during the 2015 season. As for the 2016 season, the Pioneer-985 cultivar gave the highest concentration of hydrocyanic acid at the cutting period 45 days. The reduction of hydrocyanic acid concentration in the stems has a relation with plant maturity (Loyd and Gyay, 2000).This confirms the

results obtained where the branches and stems of plants in the mechanisms stages be solid and fresh, where have the highest content of nitrogen, which leads to the result of increasing the concentration of acid hydrocyanic, but when the plant increase in ages, the stems become pyknosis and the percentage of fiber are increased at the expense of other components, leading to a decrease in the concentration of hydrocyanic acid in the stems. These results agree with the results of (Umrani and Petil, 2014; Thom and Watkin, 2012).

Table 2: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the stems for the season 2015

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	355,4	482,6	473,3	333,2	260,5	380,8
TOPAZ	486,6	560,6	572,5	479,5	272,4	480,3
Pioneer-985	616,6	688,9	663,3	582,0	334,4	575,8
G251	700,7	655,9	621,8	495,5	280,6	530,9
Local cultivar	309	585,5	490,6	342,0	248,1	395,0
Average	492,6	594,7	564,6	446,6	279,2	

LSD 0.05 for cultivars = 13.65 LSD 0.05 for interaction= 23.9
LSD 0.05 for cutting periods= 16.8

Table 3: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the stems for the season 2016

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	324,4	468,5	424,2	343,3	230,6	358,4
TOPAZ	426,2	554,5	517,5	432,6	240,5	434,2
Pioneer-985	542,6	629,4	658,6	490,3	272,3	518,6
G251	557,2	569,8	555,9	459,6	241,3	467,7
Local cultivar	364,5	478,9	425,4	351,8	233,2	370,3
Average	442,9	539,9	516,3	415,5	243,5	

LSD 0.05 for cultivars = 13.5 LSD 0.05 for interaction= 22.8
LSD 0.05 for cutting periods= 15.7

Second: Concentration of hydrocyanic acid in the leaves

Tables (4, 5) show significant differences in the concentration of hydrocyanic acid in the leaves due to the effect of the cultivars, the cutting periods and the interaction between them for both seasons (2015-2016), where the Pioneer-985 cultivar was significantly excelled on the other cultivars by giving it the highest concentration of hydrocyanic acid in the leaves (1231.9, 1289.8 ppm) for both seasons (2015 - 2016), respectively, While PRAVO-M cultivar gave the lowest concentration of hydrocyanic acid, which did not differ significantly from the local cultivar for both seasons (2015-2016).Therefore, the percentage of increase in the concentration of hydrocyanic acid to the pioneer-985 cultivar amounted to (35.5% 37.1%) compared to the PRAVO-M cultivar which gave the lowest average for the concentration of hydrocyanic acid and both seasons (2015 -2016). While the cutting periods also had a significant effect on the concentration of hydrocyanic acid, where the cutting period 35 days after cultivating was significantly excelled over other periods by giving it the highest concentration amounted to (1365.2, 1457.8 Ppm) for the season (2015-2016), respectively, While the cutting period (65) days after cultivating gave the lowest average amounted to (736.6, 697.0 ppm), and did not differ significantly from the cutting period of 55 days after cultivating, for both seasons (2015-2016).There was also a significant interaction between the cultivars and the cutting periods as shown in Tables (4, 5), where the Pioneer-985 cultivar was excelled at the cutting period 35 days after cultivating and for both seasons (2015 -2016).These results agree with (Wheeler, 1986; Lutrick, 1998) who indicated that the leaves content of hydrocyanic acid increases in the early stages and decreases as the plant progress in age and the highest average concentration of hydrocyanic acid between 10 - 30 days after cultivating, the increase in the concentration of hydrocyanic acid in the leaves during this period may be due to to increase the absorption of plant to nitrogen element, Which increases the containment of the leaves from this element and this in turn contributes to the increase the concentration of hydrocyanic acid in the plant.

Table 4: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the leaves for the season 2015

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	1118,9	1325,3	1201,6	616,9	606,7	987,8
TOPAZ	1282,8	1424,4	1221,8	703,9	716,8	1069,9
Pioneer -985	1366,5	1692,6	1443,7	1008,3	937,9	1289,8
G251	1312,4	1559,6	1371,3	800,9	735,8	1156,0
Local cultivar	1201,4	1287,3	1216,5	652,8	640,8	999,7
Average	1270,4	1457,8	1305,9	761,9	736,6	

LSD 0.05 for cultivars = 22.6 LSD 0.05 for interaction= 33.4
LSD 0.05 for cutting periods= 26.2

Table 5: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the leaves for the season 2016.

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	1101,9	1255,7	1020,8	560,6	552,5	898,3
TOPAZ	1204,8	1352,4	1165,8	648,5	636,4	1001,5
Pioneer-985	1276,9	1581,6	1360,9	989,8	950,6	1231,9
G251	1204,6	1467.8	1281,8	768,8	754,6	1095,5
Local cultivar	1062,2	1168,3	1103,8	608,8	590,9	906
Average	1170,1	1365,1	1186,5	714,7	697,0	

LSD0.05 for cultivars = 26.9 LSD0.05 for interaction= 34.2
LSD0.05 for cutting periods= 21.8

Third: Concentration of hydrocyanic acid in plants

Tables (4, 5) show significant differences in the concentration of hydrocyanic acid in the leaves due to the effect of the cultivars, the cutting periods and the interaction between them for both seasons (2015-2016), where the Pioneer-985 cultivar was significantly excelled on the other cultivars by giving it the highest concentration of hydrocyanic acid in the leaves (690, 672 ppm) for both seasons (2015 - 2016), respectively, While Bravo-m cultivar gave the lowest concentration of hydrocyanic acid, which did not differ significantly from the local cultivar. The cutting periods also had a significant effect on the concentration of hydrocyanic acid, where the cutting period 45 days after cultivating was significantly excelled over other periods except for the period (35) days after cultivating for both seasons, Where the cutting period (45) days after cultivating gave the highest concentration of hydrocyanic acid amounted to (789.5, 758.6 ppm) for the seasons (2015-2016), respectively, with a relative increase of (85.4%, 91.7%) compared to the lowest average concentration of hydrocyanic acid at the cutting period (65) days after cultivating. These results agree with the results of (Petil and Umrani, 2009; Watkin and Tome, 2008) who indicated that the concentration of hydrocyanic acid differed at the different cutting stages and indicated that the concentration of this acid was higher in the early stages of plant life and was the lowest content in the late stages (Dough Ripe Stage for the grains).The results in Tables (6, 7) showed a significant interaction between cultivars and cutting periods, Where the bi-interaction between Pioneer-985 cultivar and the cutting periods of (35, 45 days) after cultivating gave the highest average concentration of hydrocyanic acid and for both seasons 2015-2016.

Table 6: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the plant for the autumn season 2015

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	675,7	703,6	704,8	523,9	385,5	598,7
TOPAZ	679,8	780,5	793,6	568,5	436,6	651,4
Pioneer-985	650,5	884,5	808,7	565,5	459,8	690,6
G251	685,5	792,2	801,6	670,4	442,8	678,5
Local cultivar	620,0	725,4	757,8	536,2	404,6	607,8
Average	662,3	777,2	789,5	572,2	425,8	

LSD 0.05 for cultivars = 12.6 LSD 0.05 for interaction= 22.5
LSD 0.05 for cutting periods= 15.4

Table 7: Effect of cutting periods and cultivars on the concentration of hydrocyanic acid in the plant for the spring season 2016

Cultivars	Cutting periods (day)					Average
	25	35	45	55	65	
BRAVO-M	640,5	702,8	711,0	543,5	368,3	593,2
TOPAZ	614,4	753,7	786,5	590,0	411,4	631,2
Pioneer-985	669,9	782,8	795,5	679,9	434,4	672,5
G251	662,5	772,5	782,6	617,9	390,5	645,2
Local cultivar	632,9	725,8	717,4	538,6	373,6	597,6
Average	644,0	747,5	758,6	593,9	395,3	

LSD 0.05 for cultivars = 11.8 LSD 0.05 for interaction= 20.6
LSD 0.05 for cutting periods= 13.5

Conclusions

Through the results of the study obtained with regard to the toxic substance (HCN) and the extent of variability of the studied cultivars of sorghum in the percentage of hydrocyanic acid, we recommend the following.

1- Bravo-m cultivar is considered to be the best cultivar because it contains the lowest percentage of a toxic substance compared to the studied cultivars. Therefore, it is recommended to cultivate this cultivar as a feed crop beside the local cultivar, which is not significantly different.
2- The best period for cutting the plant and providing it as animal feed is 65 days and can be cut after 55 days of cultivating for the absence of significant differences between the dates (55, 65) days after cultivating for both seasons.

References

Al-Takriti, Ramadan, A.L.M. and Latif, A.M.A. (1997). Quality of feed crops and pastures - University of Mosul.

Hamad, Y.M. (1996). Effect of the cutting stages and some levels of nitrogen fertilizer and seed quantities on the value and quality of hybrid sorghum, Master thesis, College of Agriculture, University of Mosul.

Al-Sayed, R.M. and Al-Fakhri, A.Q. (1995). feed and Pasture Crops. Mosul University.

Al-Ghalebi, A.S.H. (1989). Effect of seed quantities and levels of nitrogen fertilization in feed yield and quality of the two cultivars of sorghum, MA. College of Agriculture, University of Baghdad.

Eck, V.H. (2009). The hydrocyanic acid potential in leaf blade to tissue of eleven-grain sorghum hybrids, Agron. J. 98: 348-352.

Gorashi, A.; Droison, M.P.N. and School, J.M. (2009). Effect of growth stage temperature and N and P lanes on the hydrocyanic acid potential of sorghums in the field and growth room Agron. J. 20: 45-47.

Mobee, G.G. and Miller, F.R. (2008). The hydrocyanic acid potential in the several sorghum breeding lines as affected by nitrogen fertilization and variable harvests Crop-Sci, 20: 232-240.

Loyd, R.C. and Gray, E. (2000). Amount and distribution of hydrocyanic acid potential during the life cycle of the plant of three sorghum cultivars Igron. J-62: 392-399.

Thom, E.R.B.R. and Watkin (2014). Effect of rate and time of fertilizer nitrogen application on the totalplant, shoot and root yield of maze (*Zea mays*) Newzeland. J-EXP- Agric 6: 39-48.

Umrani, N.K. and Patil, C.B. (2009). Role of management in the nitrogen response to winter sorghum under dry land condition sorghum news leafier 36: 63.

Gorz, H.J.; Haay, W.L.; Specht, J.E. and Haskins, F.A. (1998). Assay of p-. Hydroxybenzyl degree as ameasuxe of hydro –Cyanic acido potential in sorghum cropscicropsci 19: 578-588.

Haskins, F.A.H.J. and Corzand, R.L.N. (2004). Comparison of the hydrocganicacide potential of sorghum of sorghums seedlings and tiller Agron. 17: 507-515.

Steel, R.C.D. and TORRIE, J.H. (1980). Principles and procedures of statistics Mo graw-Hill Book Compauy FNC, New York.