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Influence of Cutting Number and Harvesting Dates on Yield and Seed Quality of Sudan Grass (*Sorghum bicolor var. Sudanense (Piper) Stapf.*)

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ABSTRACT

This investigation was carried out at the experimental farm of EL-Serw Agriculture Research Station and Seed Technology Research Unit Mansoura, Agricultural Research Center from 2012 to 2015 year to study the effect of cuts number (without cut (control), one cut and two cuts) and harvesting dates (25, 32, 39, and 46 days after 50% flowering) on fresh and seed yield, of Sudan grass as well as, seed quality after different storage periods. The main results can summarized as follows: Left Sudan grass plants without cut (control) and harvesting after 39 day from 50% flowering gave the highest values of plant height, straw fresh and dry weight kg/ plot, 1000-seed weight and seed yield / plot. Two cut treatments associated with the highest values of total fresh and dry forage yield/plot. Seed produced from the fourth harvest date without cutting gave the best values of seed germination percentage and seedling vigor traits followed by one cut then two cuts under different storage periods conditions. Increasing storage periods from six to 18 months led to the reduction in seed quality traits. So, sorghum Sudan grass plants one-cut before seed production could be considered the most suitable treatment to produce high yield and seed quality.

Keywords: seed production – fresh fodder - Sudan grass – harvesting date suitable –cutting – storage seed.

INTRODUCTION

Sudan grass is one of the most important grasses utilized for supplemental summer forage, mainly because of its ability of rapid growth and high potential for yield of satisfactory quality (Cullison, 1979; Seo and Kim, 1985). Sudan grass has a number of characteristics that make it well adapted to water shortages. It has waxy bloom on smaller leaf area, twice as many secondary roots per unit of primary root. These characterizes make Sudan grass a suitable emergency forage source to fill the feed shortage gap during the lean summer period in arid and semi-arid regions, where limited water a viability does not allow for the cultivation of corn. However, one of the most serious limitations for increasing the cultivation area of this crop is the lack of adequate quantity and quality of seed. Generally, the low seed production from forage crops in regions of less intensive production is mainly due to the fact that most studies have focused on evaluating the impact of practical management decisions on fodder yield and quality. It is rather unfortumate the very little attention is given to agricultural management techniques and their effects on seed production, especially in a Mediterranean environment. (Marsalis *et al*., 2010 ; Sowinski and Szydelko, 2011).

Sudan grass may be affected by cutting numbers Sowinski and Szydelko (2011) concluded that with increasing cuts number of Sudan grass, tillerring promotion and increased the number of shoots; this trait may be of benefit only when Sudan grass is cultivated for forage production. However when Sudan grass is cultivated for seed production, this trait may be have a negative impact on the number of fertile tillers per unite area, which in turn effects the quantity and quality of seed yield. Without cut treatment produced, as averaged over the 2 seasons, 52.3% and 74.5% higher seed yield and hay yield per hectare than the one- cut treatment, however, the latter treatment had harvest index and sum of hay and fresh forage yield values that were 17.0% and 19.9% higher than those of the zero-cut treatment, respectively (Awad *et al*.,2013).

Determining the optimum stage of harvest is essential to know the physical and physiological changes that occur during seed development and maturation under varying harvesting conditions, since harvesting conditions are the first and foremost factors that affect seed vigor, viability and storability, besides size, shape and uniformly (Pollock and Roos, 1972). Harvesting at 99 days after emergence gave the highest seed yield, germination percentage increased with increasing maturity at harvest (Sistach *et al*., 1998). Ochieng *et al*. (2013) selected Sorghum seed at three levels (continuous, from booting stage and at harvest), they found that standard germination, mean germination time and electrical conductivity were not influenced. Sudan grass seed germination ranged from 55.1 % (harvest 120 DAS) to 61.4% (90 DAS), and from 35.7 % (120 DAS) to 40.3 % (100 DAS) after accelerated aging (Krishnasamy *et al*., 1989). Narwal and Sharma1998 studied effect of harvest time at different seed maturity stages on seed yield of forage sorghum and they decided that, maximum seed yield of 1.52 and 1.57 t/ha was recorded 35 days after anthesis in 1992 and 1993 respectively. In the same trend, Vilas *et al*(2006), tagged and labeled ear heads at 50 % flowering and harvested from 7 days to 63 days after 50% flowering of sorghum genotypes to determined correct stage of physiological and harvestable maturity, they indicated that physiological maturity attained is at 35 and 42 days after 50% flowering respectively in all varieties with low moisture content at around 25 percent with maximum accumulation of dry weight. Ibrahim *et al*, 2012 studied four forage sorghum cultivars to determine effect of delayed harvesting time on the changes in yield and forage quality, they found that fresh forage yield, plant height, protein yield tended to increase with advanced plant maturity, so, they shown that suitable harvesting of forage sorghum is physiologic maturity stage for high yield and fodder quality.

The susceptibility to loss of viability of Sudan grass seed, stored for 12 months under adverse conditions was less than maize and bajra (Gowda *et al*., 1996). Sudan grass seed germination decreased with prolonged storage period. The lightest one had germination percentage of 70% where as the other sizes were around 80 % or greater up to 6 months after storage (Rao *et al* 1993).

Thus, the aim of this study was to determine the suitable number of cuts, optimal harvesting date for having high forage, seed yield/ plant and seed quality also study

the effect of harvesting dates on Sudan grass seed storage capacity with having high seed quality.

MATERIALS AND METHODS

1-Field experiments: -

Two field experiments were carried out during 2012 and 2013 summer seasons at El-Serw Agric. Research Station. The initial physical and chemical analysis of soil before conducts the experiments revealed in Table (1)

Table 1. Initial physical and chemical properties of soil before conducting the experiment (average of two seasons)

Soil analysis	El-Serw
Clay (%)	65.95
Silt (%)	20.18
Organic matter (%)	0.96
Fine sand (%)	12.91
Texture class	Clayey
Total N (%)	0.84
Available P (ppm)	7.4
Available K (ppm)	193
$CaCO_3$%	2.59
EC mmhos/cm	6.5
pH	8.58

Seeds of Sudan grass variety (local) were obtained from Forage Crops Research Department, Field Crops Research Institute, A.R.C. A strip-plot design with three replications was used. Each experiment includes twelve treatments comprising, three cuts treatments and four harvesting dates in both seasons. The vertical plots were assigned to three cutting treatments as follows; control treatments without cutting, where plants left for grain production, the second treatment 1 cut at 55 days after sowing and plants left for seed production, and the third treatment two cuts, the first cut at 55 days after sowing and the second cut after 30 days from the first cut then plants left for grain production. The horizontal plots were occupied with four harvesting time (25 day after 50% flowering , 32 day after 50% flowering, 39 day after 50% flowering and 46 day after 50% flowering).. The soil of experimental site has clayey in texture. The preceding winter crop was Egyptian clover in the two growing seasons. Each experimental basic unite included one ridge, each of 60 cm apart and 3m length, comprising an area of 1.8 m2. The experimental field well prepared and then divided into the experimental units. Calcium superphosphate at 150 kg / fed (15.5% P2O5) was applied during soil preparation. Sowing took place on 15th mayo in both seasons. A few seeds in each hill were sown on one side of a ridge, and two weeks after the sowing, the seedlings were thinned to plants per hill. Nitrogen in form of ammonium nitrate (33.5 %) was applied at the rate of 100 kg N / fed in two equal doses, the first was applied after thinning (21 days from sowing) and the second had done before the third irrigation .The common agricultural practices for growing Sudan grass according to the recommendations were followed.

Studied characters:

At each harvesting dates six guarded plants were pulled up from the outer ridges of each sub plot to determine the studied traits:

- Plant height (cm).
- Straw fresh weight (Kg/ plot). (plants after separate the heads)
- Straw dry weight (Kg/plot).
- 1000 weight seeds (gm).
- Seed yield (Kg/plot).
- Total fresh forage (kg/plot). (results from the one cut, two cut, in addition to straw fresh)
- Total dry forage yield (kg/plot).

Chemical compositions:

Random samples of plants were shopped into 1-2 cm pieces and thoroughly mixed. A 300 gm. sample of fresh chopped was dried in an oven at 40oC for 2 days and at 70oC for 3 days. The dried samples were chemically analyzed for nitrogen (N) and crude fiber (CF) as following the methods of A.O.A.C. (1990) in the MAU laboratory at the Agriculture Chemistry Dep.- Faculty of Agriculture – Mansoura University. Forage quality calculations according to (Church, 1979) as follows:

1- Crude protein: was calculated by the formula of N concentration x 6.25.
2- Crude fiber (CF)
3- Digestible protein (DB %) by the formula DP % = CP X 0.929 – 3.48
4- Total digestible nutrients (TDN %) = 90.36 – 0.29X CP – 0.86 X CF.

All data were statistically analyzed according to technique of analysis of variance (ANOVA) for the strip-plot design as described by Gomez & Gomez (1984) using MSTAT statistical package (MSTATC with MGRAPH version 2.10, Crop and Soil Sciences Department, Michigan State University, USA). Least Significant Differences (LSD) method was used to test the differences between treatment means at 5% level of probability as described by Snedecor & Cochran. Bartlelt test was done to the homogeneity of error variances. The data of both years in laboratory experiments were combined for all traits.

2-Laboratory experiments:-

Two laboratory experiments were conducted at the laboratories of Seed Technology Research. Unit, Mansoura, Field Crops Research Institute, ARC, from 2012 to 2015 year to determine the suitable number of cuts, harvesting date which give high seed quality after different storage period. After harvest obtained seed samples were dried and cleaned from husk, dust and any inert materials. Seed color evaluation by random sample (100 seed) from each treatment were subject for seed coat color evaluation and its color was graduated visually according to HPS//en. Wikipedia org/ wiki/ color to four color categories i.e. Buff, carnelian, Rosewood and sienna.

The studied factors were:-

1-No. of cuts
2-Harvest dates:
3- Storage periods. After each harvest date seed were air dried before storage in cloth bags, under laboratory conditions for 0, 6 and 18 months. The studied traits were recorded directly before harvest and after each storage period. The studied traits were:-

Germination percentage:

Germination percentage (G%) was calculated by counting only normal seedlings ten days after planting according to (ISTA Rules, 1999).

Speed germination index (SGI):

It was calculated according to the rules of the Association of Official Seed Analysis (A.O.S.A., 1983) by the following formula:

$$SGI = \frac{\text{No. of germinated seed}}{\text{Days of first count}} + \frac{\ldots\ldots}{\ldots\ldots} + \frac{\text{No. of germinated seed}}{\text{Days of final count}}$$

The seeds were considered germinated when the radical was at least 2 mm. long.

Conductivity test:

It was evaluated for each treatment according to the procedures outlined by Matthews and Alison (1987). The results were reported as (*mmohs/gm seed/cm*^{2}).

$$E.C = \frac{\text{Reading}}{\text{Weight of 50 seeds}}$$

- **Accelerated aging test:** was conducted according (ISTA 1999).
- **Plumule and radical length (cm):** During the final count ten normal seedlings from each replicate were taken randomly to measure plumule and radical length (cm).
- **Seedling dry weight (gm):** Ten normal seedlings were dried in hot-air oven at 85 ^{o}C for 12 hours to obtain the seedling dry weight (g) according to (Krishnasamy and Seshu, 1990).

$$\text{Germination energy} = \frac{N_1 + N_2}{M} \times 100$$

N_1, and N_2 = First and Second Counts

M = Total number of seeds planted

Data were statistically analysis according to Gomez and Gomez (1984). The treated averages were compared using the Least Significant Difference (LSD) method. Bartlelt test was done to the homogeneity of error variances. The data of both years in laboratory experiments were combined for all traits.

RESULTS AND DISCUSSION

There was a significant effect for cutting numbers on all the studied traits (Table 2). The control treatment had the highest values for plant height, straw fresh and dry weight per plot, 1000- seed weight and seed yield per plot with values 363.7 cm, 3.83 Kg/plot, 1.018 Kg/plot, 16.0 gm. and 551.1 gm./plot respectively. However, the two-cut treatment resulted in total fresh and dry forage weight per plot increases with values 17.11 and 2.68 kg / plot respectively, when compared with control and one-cut treatments. Intensive cut stress during vegetative growth stage led to reduction in seed yield and its components which resulted in the lowest values of these characters in the two growing seasons. Similar results were reported by (Awad *et al*. 2013).

Table 2. Effect of cut number and harvesting date on plant height, straw fresh and dry weight, 1000–seed weight, seed yield / plot, total fresh forage and total dry forage yield/ plot (combined over 2012 and 2013 seasons).

Characters Treatments	Plant height (cm)	Straw fresh weight (kg/plot)	Straw dry weight (kg/plot)	1000- seed weight (gm)	seed yield (kg/plot)	Total fresh forage yield (kg/plot)	Total dry forage yield (kg/ plot)
A-Cutting number							
C1-Control (without cut)	363.7	3.83	1.018	16.0	551.1	3.84	1.02
C2-(One cut)	306.4	2.18	0.592	12.8	391.7	8.83	1.57
C3-(Two cut)	224.9	1.94	0.433	9.9	205.7	17.11	2.68
LSD at 5%	22.0	0.81	0.089	1.7	29.5	0.85	0.13
B-Harvesting dates							
D1-(25 DAF)	278.9	2.73	0.564	9.9	266.0	9.93	1.68
D2-(32 DAF)	289.3	2.77	0.706	12.8	419.9	9.98	1.63
D3-(39 DAF)	309.9	2.96	0.766	15.0	465.9	10.24	1.92
D4-(46 DAF)	315.2	2.14	0.688	13.9	379.4	9.55	1.80
LSD at 5%	21.0	0.69	0.076	1.5	25.2	0.73	0.11
C-Interaction (C × D)							
C1D1	362.0	4.04	0.817	11.9	352.5	4.04	0.82
C1D2	354.5	4.16	1.092	16.0	657.7	4.16	1.08
C1D3	368.2	4.09	1.195	18.5	655.0	4.07	1.21
C1D4	370.2	3.04	0.967	17.7	539.1	3.08	0.97
C2D1	269.2	2.24	0.500	11.5	283.6	8.82	1.50
C2D2	298.5	2.30	0.585	12.9	403.0	8.60	1.47
C2D3	325.5	2.15	0.632	14.1	505.2	9.19	1.67
C2D4	332.5	2.02	0.652	12.7	374.9	8.72	1.62
C3D1	205.5	1.91	0.375	6.4	161.9	16.93	2.71
C3D2	215.0	1.85	0.442	9.4	199.0	17.18	2.35
C3D3	236.2	2.65	0.470	12.4	237.6	17.45	2.87
C3D4	243.0	1.37	0.447	11.3	224.1	16.87	2.81
LSD at 5%	25.0	NS	0.101	1.9	33.5	NS	0.14

C1,C 2,C3 = cutting number, DAF = harvesting dates after 25,32,39,46 days from 50% flowering, C ×D = Interaction between cutting , and harvesting dates.

The application of harvesting date 39 DAF resulted in the highest values of straw fresh and dry weight, 1000-seed weight, seed yield, total fresh and dry yield with values 2.96 kg/ plot, 0.766 gm./plot, 15.0 gm., 465.9 gm./ plot, 10.24 and 1.92 Kg / plot, respectively. Meanwhile the highest mean of plant height 312. 2cm was recorded from harvesting date 46 DAF. These results are in line with those stated by Sistachs *et al*. (1998). Similar findings were stated by Narwal and Sharma (1998) they recorded that, the maximum seed yield after 35 days after anthesis. Vilas *et al*., 2006, stated that physiological maturity attained at 35 and 42 days after 50% flowering.

There was significant effect due to the interaction between cutting treatments and harvesting dates on all the studied traits except straw fresh weight and total fresh forage yield where insignificant effects were noticed. The highest mean of plant height (370.2 cm) was recorded from harvesting left plants without cut for seed production after 46 DAF.

The best values of straw dry weight and 1000-seed weight were obtained from control treatment which harvested after 39 day from 50% of flowering. On the other side, the highest mean of seed yield (657.7 Kg /plot) was recorded from control treatment when harvested after 32 DAF. The highest value of total dry forage yield (2.87 K/ plot) was obtained from harvesting left plants without cut after 39 day from flowering. The significant reduction in seed yield was indirectly related to exhausted plants (low level of reserved carbohydrates) after cutting (Everson, 1966).

The effect of cut number and harvest date and their interaction on chemical composition for the straw (plants without tassel) was significant (Table, 3). Forage quality i.e. crude protein (CP), crude fiber (CF), digestible protein (DP), total digestible nutrients (TDN) percentages significantly affected due to cutting treatments as presented in Table 3. The highest values of CP (11.6%) and DP (7.29%) were resulted from control treatments (without cutting).

Table 3. Straw plants (without heads) chemical composition (%) as affected by cut number and harvest date (combined data over 2012 and 2013 seasons).

Characters Treatments	CP%	CF%	DP%	TDN
A-Cutting number				
C1-Control (without cut)	11.60	12.26	7.29	76.45
C2-(One cut)	9.78	13.46	5.60	75.95
C3-(Two cut)	10.14	12.40	5.86	76.78
LSD at 5%	0.38	0.23	2.01	0.47
B-Harvesting dates				
D1-(25 DAF)	13.74	10.49	9.28	77.35
D2-(32 DAF)	12.48	11.59	8.11	76.77
D3-(39 DAF)	8.03	13.93	3.98	76.06
D4-(46 DAF)	7.77	14.81	3.63	75.40
LSD at 5%	0.26	0.38	1.22	0.30
C-Interaction (C × D)				
C1D1	15.27	9.50	10.70	77.76
C1D2	13.58	11.16	9.13	76.82
C1D3	8.94	13.84	4.82	75.87
C1D4	8.60	14.53	4.51	75.36
C2D1	12.67	11.78	8.28	76.56
C2D2	11.04	12.27	6.77	76.61
C2D3	7.74	14.48	3.71	75.66
C2D4	7.66	15.29	3.64	74.98
C3D1	13.29	10.19	8.87	77.74
C3D2	12.83	11.35	8.44	76.88
C3D3	7.41	13.45	3.41	76.64
C3D4	7.04	14.60	2.75	75.86
LSD at 5%	0.72	0.47	NS	NS

C1,C2,C3 = cutting number, DAF = harvesting dates after 25,32,39,46 days from 50% flowering,
C ×D = Interaction between cutting no. and harvesting dates

However, taking one cut increase the crude fiber (13.46%). On the other hand cutting stress treatments led to gradual increases in TDN (76.76%) which produced from taking two cutting. This effect of cutting stress during growth shortage vegetative stage and seed formation may be due to the reduction in photosynthesis process and dry matter accumulation which consequently decreasing crude protein and digestible protein.

Harvesting dates had a significant effect on crude protein (CP), crude fiber (CF), digestible protein (DP), and total digestible nutrients (TDN) percentages. The highest percentage of CP (13.74%), DP (9.28%), and TDN (77.35 %) were resulted from 25 day after flowering (DAF). On the contrary harvesting after 46 day after flowering (DAF) recorded the highest percentage for CF (14.81).These results agreement with Ibrahim *et al* (2012). With respect to the effect of the interaction between cutting treatments and harvesting dates, there was significant effect on all parameters except DP % and TDN%. The highest percentages of crude protein, digestible protein, and total digestible nutrients were produced from without cutting treatment and harvesting after 25 days after 50% flowering (D1). While, the highest percentage of CP able obtained as a result of taking one cut and harvesting after 25 day after 50% flowering (D1). Thus, it can be take one cut and harvest after D1 or D2 for get double purpose, by used the residual plants after separate the heads (straw fresh) for forage and seed production.

From data presented in Table 4 and Fig1, left plants without cut produced Sienna (dark) seed coat color when harvested after 39 or 46 days with high seed quality and good stability for 18 months. Followed by plants which produce one cut before seed production forming Buff and carnelian seed coat color (light), the Sienna color appeared only at the last harvest date (46 day). On contrast, Sudan grass produce plants which produce two cuts before seed production forming 100% Buff color (light) at the first harvest date (25 day) with low seed viability and storage ability specially when harvested after 25 or 32 day from flowering. These results are agreement with Pedersen and Toy (2001) who reported that seedling emergence under field conditions was higher for the red seed than the white seed phenotype.

Table 4. Effect of interaction between No. of cuts and harvest date on seed coat color.

Treatments Number of Cuts	Harvesting Dates (day)	Buff	Carnelian	Rosewood	Sienna
Witout cut (control)	25 (DAF)	34.0	35.3	30.7	0
	32 (DAF)	0.0	72.7	26.3	0
	39 (DAF)	0.0	0	0	100
	46 (DAF)	0.0	0	0	100
One Cut	25 (DAF)	49.3	50.7	0	0
	32 (DAF)	43.7	56.3	0	0
	39 (DAF)	0	63.3	36.7	0
	46 (DAF)	0	0	24.7	75.3
Two cuts	25 (DAF)	100	0	0	0
	32 (DAF)	61	39	0	0
	39 (DAF)	33.7	66.3	0	0
	46 (DAF)	0	40.3	59.7	0
LSD at 5%			4.2		

DAF: days after 50 % of flowering.

The results in Table 5 show the effect of interaction between number of cuts and harvesting dates on Sudan grass seed germination percentage and seedling vigor traits directly after harvest (0 storage period). Significant differences among number of cuts on all the studied traits when harvested at different dates. Increasing number of cuts lead to decreasing in germination percentage, seed and seedling vigor traits. Conversely, increase harvesting dates from 25 to 46 day after 50% flowering under number of cuts, significantly increased G%, seedling length, seedling dry weight, germination after aging and speed of germination index on the opposite trend electrical conductivity (E.C.) values decreased by increasing harvest date .For example, in germination% of the fourth harvest date (46 day after 50% flowering) under without cuts (control) was 99.3%while it was decreased to 81.3% when harvested the plant at the first harvest date (25 day after 50% flowering)

Fig 1. Sudan grass seed color where C1, C2 and C3 (without cut, one cut and two cuts), D1, D2, D3 and D4 (25 DAF, 32 DAF, 39 DAF, 46 DAF).

Table 5. Effect of interaction between number. of cuts and harvesting date on germination percentage %, speed germination index, electrical conductivity, accelerated aging, seedling length, seedling dry weight , germination energy at harvest .

Characters Treatments Number of Cuts	Harvesting Dates (day)	germination percentage	speed germination index	Electrical conductivity *(mmohs/gm seed/cm^2)*	Accelerated aging test %	Seedling Length (cm)	Seedling Dry weight (gm)	germination energy
Without	25 DAF	81.3	44.0	0.050	63.3	16.19	0.176	65.3
	32 DAF	93.3	57.0	0.035	75.3	20.81	0.179	77.7
	39 DAF	97.0	70.0	0.021	81.3	24.94	0.226	95.0
	46 DAF	99.3	73.7	0.016	84.7	25.88	0.263	97.0
One Cut	25 DAF	70.3	38.0	0.059	59.3	15.13	0.146	55.3
	32 DAF	83.3	51.0	0.047	66.7	17.07	0.171	69.3
	39 DAF	92.3	65.0	0.044	75.0	21.28	0.200	88.7
	46 DAF	95.7	70.3	0.034	79.3	22.85	0.220	92.3
Two cuts	25 DAF	52.0	27.3	0.105	42.7	12.84	0.095	39.3
	32 DAF	61.0	36.7	0.091	51.3	15.27	0.122	52.0
	39 DAF	77.0	44.7	0.063	66.7	17.66	0.144	64.0
	46 DAF	83.7	48.3	0.055	70.7	18.01	0.171	70.3
LSD at 5%		2.0	2.5	0.003	2.09	1.42	0.012	NS

DAF: days after 50 % of flowering.

Similarly, the germination after aging was 84.7% at fourth harvest date while it was reduced to 63.3% at the first one. Also, the best values of electrical conductivity were obtained at the fourth harvest date (0.016 mmohs/gm seed/cm2) while, the first harvest date recorded the lower value (0.050 mmohs/gm seed/cm2), under two cuts the same trained was observed, the values were almost lower for example seedling dry weight was 0.220g under the fourth harvest date, while it was decreased to 0.263 g under without cuts. This implies that as number of cuts increases, seed quality decreases, meanwhile, seed quality increases when harvest done under the different cuts. These results are in line with Pollock and Roos (1972) they reported that harvesting conditions are the first and foremost factors that effect seed vigor, viability and storability. While Sowinski and Szydelko (2011) concluded that number of cuts of Sudan grass may be have a negative impact on seed quality. When seed production is desired Sudan grass should not be cut. If growers are interested in fresh forage production and seed simultaneously, Sudan grass can be cut one time (Awad *et al* 2013).

A perusal of the transformed data regarding germination% seed and seedling quality traits under the second storage period (Table 6) significant difference was detected between the number of cuts x harvest date. However, the efficiency of increase the harvesting date through number of cuts is reflected by its tallest seedling length. For example, under one cut seedling length was 15.0 cm at the first harvest date while, the tallest one (20.4cm) was obtained with fourth harvesting date. Similar trend was observed under two cuts.

In case of E.C a higher electrolyte loss recorded at the first harvesting date through the number of cuts where as lowest leakage loss better quality noticed at the fourth harvest date under without cutting (0.020 *mmohs/gm seed/cm*^{2}). Compared to higher electrolyte loss recorded in the first harvest date under two cuts (0.116 *mmohs/gm of seed/cm*^{2}) , lowest leakage noticed in the fourth harvest date(0.060 *mmohs/gm of seed/cm*^{2}) which indicated of higher seed vigor and quality . Poor seed vigor and quality may also ascribed to prolonging storage period. As storage period increase seed quality decrease (Tables 5 and 6).

The total of fresh forage and dry yield for the one cut treatment was higher than that of the without cut treatment by only. This implies that when seed production is a main target, Sudan grass should not be cut. The significant reduction in seed yield in the treatment one cut and left for seed production may be due to the limited number of days between cutting and harvest; its not long enough to produce the leaf area necessary to intercept most of incoming radiation and convert it to chemical energy through photosynthesis addition, the shorter grain filling duration and maturity period of the one cut treatment may result in a significant reduction in fertile panicle numbers and reduced seed–set percentages by increasing seed abrogation and abnormality due to an inadequate energy source (Awad *et al*., 2013) .

However, the longer growth duration with without cut treatment increases the solar radiation available during the crop growth period, leading to an increase in the rate and duration of dry matter accumulation and ultimately, the final seed yield of a crop. (Awad *et al*.,2013). On the other hand, prolong storage period from harvest until next planting is about 6 months also, remainder seed after planting time is over should be stored for further 12 months until second planting season comes up. Through this period the temperature in the open–air storage decreases in the winter months and increase again in the summer months.

Such temperature changes would followed by changes in the moisture content of stored seeds which could be the main reason for seed deterioration with prolong the storage period for 12 or 18 months. The deterioration in quality characters might be due to, with prolong storage periods, seed of Sudan grass might be infested with stored pests (insects and fungi) or might be due to, the increase of some organic compounds consumption in respiration process with extend storage periods. The results were agreement with (Mersal *et al*. 2006 and Rao *et al*., 1993).

Table 6. Effect of interaction between number. of cuts and harvesting date on germination percentage %, speed germination index, electrical conductivity, accelerated aging, seedling length, seedling dry weight , germination energy after 6 months from storage.

Treatments		germination percentage	speed germination index	electrical conductivity *mmhos/gm seed/cm*^{2}	Accelerated aging test %	Seedling Length (cm)	Seedling Dry weight (gm)	germination energy
Number of Cuts	Harvesting Dates (day)							
Without cut (control)	25(DAF)	79.0	44.7	0.051	57.0	16.15	0.156	65.3
	32 (DAF)	91.0	54.7	0.029	67.3	19.13	0.171	77.7
	39 (DAF)	95.0	67.0	0.025	75.3	23.19	0.218	95.0
	46 (DAF)	97.0	68.3	0.020	80.0	25.01	0.259	97.0
One Cut	25 (DAF)	64.7	36.7	0.068	50.3	14.98	0.128	55.3
	32 (DAF)	78.7	47.3	0.056	58.3	15.97	0.158	69.3
	39 (DAF)	88.7	60.7	0.044	67.3	19.05	0.174	88.7
	46 (DAF)	92.3	64.3	0.034	73.0	20.39	0.198	92.3
Two cuts	25 (DAF)	52.0	25.7	0.116	30.3	11.64	0.077	39.3
	32 (DAF)	61.0	32.3	0.097	40.0	14.21	0.110	52.0
	39 (DAF)	77.0	40.0	0.072	56.3	16.54	0.136	64.0
	46 (DAF)	83.7	45.0	0.060	61.3	17.39	0.162	70.3
LSD at 5%		2.1	2.6	0.003	2.3	0.98	0.013	2.2

DAF: days after 50 % of flowering.

Table 7. Effect of interaction between number of cuts and harvesting date on, germination percentage %, speed germination index, electrical conductivity, accelerated aging, seedling length, seedling dry weight , germination energy after 18 months from storage.

characters Treatments Number of Cuts	Harvesting Dates (day)	germination percentage	speed germination index	electrical conductivity mmohs/gm *seed/cm*^{2}	Accelerated aging test %	Seedling Length (cm)	Seedling Dry weight (gm)	germination energy
Without cut (control)	25 DAF	64.7	31.0	0.075	38.3	14.15	0.103	50.7
	32 DAF	79.0	40.0	0.065	48.3	17.19	0.106	64.0
	39 DAF	78.3	47.7	0.044	57.7	21.37	0.157	74.3
	46 DAF	87.7	52.0	0.039	63.3	22.85	0.191	78.7
One Cut	25 DAF	49.0	23.7	0.117	29.3	12.77	0.080	37.3
	32 DAF	65.3	32.7	0.084	37.7	13.55	0.097	50.3
	39 DAF	78.0	42.0	0.064	48.0	17.88	0.120	65.3
	46 DAF	82.0	47.0	0.052	54.7	18.13	0.141	70.7
Two cuts	25 DAF	25.3	14.3	0.173	5.07	9.01	0.052	25.7
	32 DAF	36.3	21.0	0.149	15.0	11.01	0.070	36.3
	39 DAF	56.7	32.7	0.109	33.0	13.90	0.087	56.7
	46 DAF	64.3	37.7	0.061	39.7	14.60	0.109	64.3
LSD at 5%		1.8	NS	0.007	2.3	0.91	0.009	4.5

DAF: days after 50 % of flowering.

CONCLUSION

It can be concluded that. Seed produced from the fourth harvest date without cutting resulted in the best values of seed germination and seedling vigor (sienna color) followed by one cut then two cuts. Increasing number of cuts will decrease the seed yield. Increasing sorghum Sudan grass seed storage for six and 18 months resulted in lowering seed quality as indicated by reduction in seed germination, seed and seedling vigor, so, sorghum Sudan grass plants one- cut before seed production could be considered the most suitable treatment to produce high yield and seed quality.

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تأثير عدد الحشات ومواعيد الحصاد علي محصول البذور وجودتها في محصول حشيشة السودان

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أجري هذا البحث بالمزرعة البحثية بمحطة البحوث الزراعية بالسرو ومعامل وحدة بحوث تكنولوجيا البذور بالمنصورة – مركز البحوث الزراعية ، خلال الفترة الزمنية (٢٠١٢- ٢٠١٥م) وذلك بهدف دراسة تأثير عدد الحشات (نباتات تركت بدون حش لإنتاج البذور – نباتات تم حشها مرة واحدة وتركت لإنتاج البذور –نباتات تم حشها مرتين ثم تركت لإنتاج البذور) ومواعيد الحصاد (٢٥ ، ٣٢، ٣٩ و ٤٦ يوم بعد ٥٠% إزهار) على المحصول الأخضر، ومحصول البذور وجودتها لحشيشة السودان عقب فترات التخرين المختلفة (صفر ، ٦، ١٨ شهر)، ويمكن تلخيص النتائج على النحو التالي: أعطت النباتات التي تركت بدون حش لإنتاج البذور أعلى قيم لطول النبات في والمحصول الطازج والجاف /البلوط، ووزن الـ ١٠٠٠ بذرة ومحصول البذور/ البلوط، أعطت النباتات التي تم حشها مرتين قبل أن تترك لإنتاج البذور أعلى قيم لمحصول العلف الطازج والجاف / البلوط، أعطت البذور الناتجة من النباتات التي تركت بدون حش لإنتاج البذور أعلى قيم للنسبة المئوية للإنبات وصفات قوة البادرات، تلاها النباتات التي تم حشها مرة واحدة قبل تركها لإنتاج البذرة ، ثم النباتات التي تم حشها مرتين قبل تركها لأخذ البذور عقب فترات التخرين المختلفة. أدى زيادة مدة التخزين من ٦الي ١٨ شهر إلى انخفاض انبات وقوة انبات البذور والبادرات خاصة البذور الناتجة من النباتات التي تم حشها مرتين قبل تركها لإنتاج البذرة. وتوصي الدراسة الحالية بحش نباتات حشيشة السودان حشة واحدة ثم تركها لإنتاج البذرة، وهذه تعتبر أنسب معاملة للحصول على أعلى محصول علف وجودة بذرة.

الكلمات الدالة : انتاجية البذرة – العلف الأخضر – حشيشة السودان – الميعاد الأمثل لحصاد البذرة – الحش- تخزين التقاوي .