

**ASSESSMENT OF RESISTANCE TO PINK STEM BORER AND APHID INFESTATION  
IN SWEET SORGHUM CULTIVARS AND THEIR PRODUCTIVITY  
AND TECHNOLOGICAL TRAITS UNDER FOUR SOWING DATES**

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**ABSTRACT**

Two field trials were conducted at El-Fayoum Governorate, Tamia district (29°17N, 30°53E), Egypt, during summer 2017 and 2018 seasons, to evaluate the susceptibility to two dangerous insect pests *i.e.* pink stem borer (*Sesamia cretica*) and corn leaf aphid (*Rhopalosiphum maidis*) under natural infestation, the productivity, quality of ten sorghum cultivars (Brands, Dale, Honey, Leoti, Planter, Rex, Rio, Tracy, Umbrella and Williams) sown under four sowing dates (Mid. April, May, June and July). The results of the separate and combined seasons indicated that all noticeable signs of damage parameters of pink stem borer and corn leaf aphid significantly increased gradually with delaying sorghum sowing. Sowing in mid June or July suffered more damage to both insects as compared with early sowing. Regarding the noticeable damage signs. It significantly differed among the ten sweet sorghum cultivars, where, Rio, Dale and Williams cultivars recorded the least infestation which gave evidence that those cultivars were relatively tolerant to both insects, while, Honey and Umbrella cultivars recorded the highest infestation features. Quality traits (TSS, Sucrose% and reducing sugars) insignificantly differed among the four sowing dates and cultivars. Juice Extraction Percentage (JEP), glucose ratio (GR) and juice purity significantly differed among the four sowing dates. The values of JEP and juice purity decreased gradually as sowing date delayed, while, GR recorded the lowest value on May sowing as compared with other three sowing dates. On the contrary, Syrup Extraction Percentage (SEP), Total Fermentable Sugars (TFS) and Fiber % were insignificantly differed among the four sowing dates. Great variation has been detected for all processing parameters among the tested cultivars except TFS%. The results also showed that all productivity traits were significantly decreased as sowing date delayed to reach its minimum at July sowing. Productivity clarified that average stripped stalk wt., stripped stalk, juice, syrup and ethanol yields significantly differed among the tested cultivars (except forage yield). Rio cultivar yielded the highest productivity traits, while, Honey cultivar exhibited the lowest ones. The variation observed among the tested sorghum cultivars for all studies traits were markedly related to the tolerance and susceptibility of used the tested cultivars to pink stem borer and corn leaf aphids which measure by many constant parameters as discussed previously. In general, Rio, Dale and Williams sorghum cultivars sown on mid April sowing dates exhibited the higher productivity and quality traits and the lower damage signs or to some extent characterized as relatively tolerance to pink borer and corn leaf aphid infestation.

**Key words:** *sweet sorghum, resistance, stem borer, sowing dates.*

**1. INTRODUCTION**

Sorghum (*Sorghum bicolor* (L.), Moench) is one of the important food, Feed and fodder crops in arid and semi arid regions of the world (Shoemaker and Bransby, 2010). The sweet stalk sorghum possesses sweet juice in their stalk tissue. Further, the ability of sweet sorghum to adapt to drought, saline soil and water logging is very high. Moreover, short

growing period, low water requirements, lower cost of cultivation compared with sugarcane and sugarbeet (Audilakshmi *et al.*, 2010 and Xin and Wang, 2011). Sweet sorghum is a multipurpose crop due to its capacity to provide renewable energy product (ethanol), industrial commodities and concentrated syrup with distinctive flavour, forage and some varieties could used for refining sugar production (Allam *et al.*, 2001;

Almodares *et al.*, 2009 and Aman, 2010).

Sorghum plants in Egypt are severely attacked by different species of lepidopteron insects. The most prevalent and dangerous is pink stem borer, *Sesamia cretica* (Led.). This insect attacks sorghum plants after emergence devours the whorl leaves and kills the growing meristem tissue, causing dead heart (Mailafiya and Degri, 2012). The insect is also capable to damage older plants and excavating tunnels into the stem. This insect greatly and negatively affected stalk, grain, forage yields, juice quantity and quality (Abd El-Razek *et al.*, 2014; Amer and Besheit, 2016 and Besheit and Mekdad, 2016). Moreover, stem borers are difficult to control largely because of nocturnal habits of adult moth and the cryptic feeding behavior of the larvae, which resides inside the plant stem. There is scanty information on the resistance of stem borer in sweet sorghum; therefore, efforts will largely focus not only on high yielding stems but also to select tolerance varieties.

Furthermore, among the sap sucking pest insect are aphids (Hemiptera: Aphididae) is corn leaf aphid (*Rhopalosiphum maidis* Fitch) (Blackman and Eastop, 2000; Amin *et al.*, 2013 and Aly and Besheit, 2014). Aphids cause direct damage as phloem feeders, and inject a toxin which destroy the chloroplast membranes and indirect damage as plant virus vectors and secreting honey dew which become suitable media for sooty moulds (Helmi and Rashwan, 2013).

In addition, great attention have been paid by many workers to the importance of sowing date and cultivars on quantity and quality of sweet sorghum, and proper cultivars in suitable sowing date which perform high yielding ability, chemical and technological characteristics (El-Rawy *et al.*, 2013; Djodda *et al.*, 2013; El Geddawy *et al.*, 2014; Amer and Besheit, 2016 and Besheit and Mekdad, 2016).

This work aimed to assess the productivity and quality of ten sweet sorghum cultivars and its sensitivity to pink stem borer and corn leaf aphid infestation under four sowing dates at El-Fayoum Governorate.

## 2. MATERIALS AND METHODS

To evaluate the productivity, quality and susceptibility to the most dangerous insect pest pink stem borer [*Sesamia cretica* Led., Lepidoptera, Noctuidae] and corn leaf aphid of ten sorghum cultivars namely Brands, Dale, Honey, Leoti, Planter, Rex, Rio, Tracy,

Umbrella and Williams sown under four sowing dates on mid April, May, June and July, two field trials were conducted in Khalifa Youns, Tamea district El-Fayoum Governorate (29°17 N, 30°53 E), Egypt during 2017 and 2018 seasons. Split plot design with four replicates was used. Sowing dates occupied the main plots, while, cultivars were randomly distributed in the sub plots units. Plot size was 21 m<sup>2</sup> (1/200 Fed.), consist of 5 rows, 7 m long and 60 cm apart within inter row spacing of 25 cm.

Seedlings were thinned at two plants per hill after 3 weeks from sowing date. Nitrogen (60 kg N/ fed.) was applied in three equal doses one third after thinning directly. The second and the third doses were added after 7 and 10 weeks from planting, respectively. Further, calcium super phosphate (15.5 P<sub>2</sub>O<sub>5</sub>) at the rate of 100 kg/ fed. was applied during land preparation. All other cultural procedures were carried out as usual. Application of insecticides was excluded throughout the whole season. Harvest was carried out at the ripe stage in both seasons. The three middle guarded rows were used to determine millable stalk yield. Twenty five stripped stalks were taken randomly from each plot and immediately crushed through 3 roller lab. The raw juice was filtered and weight to calculate juice extraction percentage (JEP) and juice yield/fed. from the following equation:

$$\text{JEP} = (\text{Juice weight} / \text{stripped stalks weight}) \times 100$$
$$\text{Juice yield (ton/fed.)} = (\text{stripped stalk yield} \times \text{JEP}) / 100$$

Three kg juice from each sample was used for syrup manufacture. Syrup extraction percentage (SEP) and syrup yield (ton/fed.) were calculated from the following equations:  $\text{SEP} = (\text{Syrup weight} / \text{Juice weight}) \times 100$

$$\text{Syrup yield} = \text{Juice yield} \times \text{SEP}$$

Theoretical ethanol yield (EtOH) was calculated according to Smith and Buxton (1993)

Juice quality including Total Soluble Solids (TSS or Brix), Sucrose % (Pol), reducing sugars and purity percentages were determined according to the methods of Meade and Chen (1977).

Infestation parameters:

1. Dead heart percentage was calculated before thinning according to Maareg *et al.* (1993).
2. Infested stalk percentage (Infestation incidence) = No. of bored stalks / No. of examined stalks  $\times 100$ .
3. Infested joints percentage (Infestation intensity) = No. of infested joints / No. of examined joints  $\times 100$ .
4. No. of larvae / 25 plants.

- 5.No. of holes / 100 joints.
- 6.Tunnels percentage.
- 7.Average tunnel length.
- 8.No. of aphids /plant.
- 9.No. of infested plant / 25 plants.

Percentage data were transformed by Arcsin units before statistical analysis. Statistical analysis was performed according to the technique of analysis of variance (ANOVA) of split plot in Randomized Complete Block Design as published by Gomez and Gomez (1984), using MSTATE statistical package (Mstate-C). Treatment means were compared using L.S.D. at 5% level of probability.

### 3. RESULTS AND DISCUSSION

#### 3.1. Damage parameters

The most destructive insect pest that attack sorghum genus is pink stem borer (*Sesamia cretica* Led., Lepidoptera, Noctuidae). It causes considerable damage along the whole plant cycle in both leaf and stalks (Djodda *et al.*, 2013; Amer and Besheit, 2016 and Besheit and Mekdad, 2016). This damage is measured by many constant parameters expressed as dead heart (DH), infested bored stalks percentage (infestation incidence), infested bored joints percentage (infestation intensity), No. of larvae /25 plant, No. of holes/ 100 joints, No. of tunnel % plants and average tunnel length cm. Meantime, corn leaf aphid (*Rhopalosiphum maidis* Fitch) on sorghum leaves is a serious sap sucking insect pest. The combined data for 2017 and 2018 seasons (Table 1) and the separate seasons (not presented) that illustrate all noticeable sign of damage parameters are shown in Table (1). These parameters increased gradually and significantly with delaying sorghum sowing. Plants at sowing during June and July suffered more damage by borers as compared with sowing during April and May. Such effect may be due to the fact that plantations during April and May are more favorable in terms of temperature, day length and light intensity, than those prevailing during June and July, especially in the seedling stage and hence greatly and negatively reflected on yields, quality and technology traits (Abdel-Gawad, 1981). These findings are in general agreement with those of Almodares *et al.* (1994); and Besheit *et al.*, (1996).

Regarding corn aphid infestation, the combined data in Table (1) stated that corn

aphid infestation took the same tendency as pink stem borer with respect to sowing date. Gradual and significant increase in aphid population density/ plant and No. of infested plant percentage with delaying sowing up to June and July. These results are in accordance with those of Munson *et al.*, 1993.

Combined data across 2017 and 2018 seasons (Table 1) and the other years (not presented) indicated that dead heart infestation significantly differed among the tested ten sweet sorghum cultivars, where, Williams, Leoti, Dale, Brands, Rio and Rex recorded the lowest infestation. Honey cultivar exhibited the highest dead heart. Regarding the other noticeable damage signs *i.e.* infestation incidence, infestation intensity, No. of larvae/ 25 plants, No. of holes/ 100 joint, No. of tunnel % and tunnel length cm, Rio cultivar declared the lowest values of all damage parameters, followed by Dale and Williams cultivars. These findings gave evidence that those cultivars are relatively tolerant to pink stem borer infestation. On the other hand, the other cultivars recording high damage parameters could be considered more sensitive to infestation. The highest susceptibility cultivars were Honey and Umbrella which recorded the highest infestation parameters. These findings gave evidence that none of the used cultivars were immune to pink stem borer, *S. cretica* as shown in other years. The variation among the used cultivars may be due to genetic causes and / or the interaction between the genotypes and environment at conditions prevailing during the four sowing dates. These findings are in harmony with those of Mailafiya and Degri, 2012; El-Rawy *et al.*, 2013 Nuessly *et al.*, 2013; Salman *et al.*, 2014 and Besheit and Mekdad, 2016).

Combined data across 2017 and 2018 (Table 1) cleared that No. of corn aphid/ plant and No. of infested plants percentage were substantially differed among the ten sorghum cultivars. Further, No. of individuals/ plant was fluctuated between 241.84 for Rio cultivar and 398.42 for Honey cultivar and No. of infested plants percentage was range in 3.59 and 6.51 for the same cultivars (Table 1). In general, data cleared that no cultivars appeared to have absolute immunity towards this destructive insect pest but those cultivars showed some degree of tolerance and susceptibility to some insect attack.

**Table (1): Influence of sowing dates and cultivars on borer and aphid infestation (combined over 2017 and 2018 seasons).**

Factors	Borer infestation							Corn leaf aphids	
	Dead hearts %	Incidence %	Intensity %	No. of larvae /25 plants	No. of holes / 100 joint	Tunnel %	Tunnel length cm	No. of aphid/ plant	No. of infested plants
<b>Years (Y)</b>									
2017	6.36	12.04	4.44	3.74	9.33	11.77	6.30	264.77	3.90
2018	7.42	15.99	6.67	5.22	13.60	13.87	7.05	377.78	6.37
Sign.	**	**	**	**	**	**	**	**	**
L.S.D. 5%	0.51	1.10	0.58	0.35	0.73	0.99	1.05	15.83	0.52
<b>Sowing dates (S)</b>									
15 April	5.99	12.81	4.25	4.60	7.96	8.94	4.45	289.50	3.89
15 May	6.47	12.53	5.64	4.36	9.35	10.86	5.37	273.05	3.67
15 June	7.01	14.98	5.97	4.48	14.72	15.91	7.89	345.69	6.59
15 July	8.09	15.76	6.38	4.47	13.85	15.57	9.01	376.84	6.41
Sign.	**	**	*	N.S	**	**	**	**	**
L.S.D. 5%	0.51	0.84	0.46	-	0.51	1.43	1.27	39.54	0.31
<b>Cultivars (C)</b>									
Brands	6.23	14.83	5.65	4.09	11.85	13.42	6.17	338.00	5.50
Dale	6.17	11.42	4.25	3.67	10.70	11.26	4.70	282.75	4.75
Honey	7.94	17.87	7.62	6.42	13.92	16.42	10.10	398.42	6.51
Leoti	6.09	12.71	4.96	3.84	10.61	11.59	6.15	312.17	5.09
Planter	7.74	14.65	6.03	4.76	12.23	13.67	7.80	322.75	5.25
Rex	6.71	14.41	5.60	4.51	11.17	12.76	6.47	311.67	4.92
Rio	6.62	9.73	3.78	2.50	8.05	8.92	3.05	241.84	3.59
Tracy	7.76	15.33	6.06	5.17	12.58	14.26	8.28	348.26	5.51
Umbrella	7.59	16.75	6.71	5.84	13.39	15.34	8.70	369.59	5.42
Williams	6.08	12.48	4.94	4.01	10.19	10.59	5.34	287.25	4.84
Sign.	*	**	**	**	**	**	**	**	**
L.S.D. 5%	0.64	1.20	0.99	1.42	0.94	2.18	0.87	59.95	1.20
<b>Interactions</b>									
YxS	**	**	N.S	N.S	**	N.S	N.S	**	N.S
YxC	**	**	**	**	**	**	**	**	*
SxC	**	**	**	*	**	**	*	**	N.S
YxSxC	**	**	**	N.S	**	N.S	N.S	**	N.S

### 3.2. Quality traits

Combined results (2017 and 2018 seasons) of the total soluble solids (TSS), sucrose % and reducing sugars insignificantly differed among the four sowing dates (Table 2). The results also cleared that the separate seasons were insignificant for sucrose and reducing sugars only, even so, the values of three quality traits were higher in 2018 than 2017 season.

With regard to cultivars effect on the three quality traits, the differences among the cultivars

did not reach the level of significance for the three quality traits. These results gave evidence that quality traits were affected greatly by climatic change from year to another than genetic constituents. These results are corroborate those of Allam *et al.* (2001), Al-Labbody *et al.*, (2008), Amer and Besheit (2016) and Besheit and Mekdad (2016).

### 3.3. Technological traits

Results (Table 2) indicated that juice extraction percentage (JEP) was significantly

**Table (2): Influence of sowing dates and cultivars on quality and technological traits (combined over 2017 and 2018 seasons).**

Factors	Quality traits			Technological traits					
	TSS %	Sucrose %	Reducing sugars	JEP %	SEP %	Glucose ratio (GR)	Purity	TFS	Fiber %
<b>Years (Y)</b>									
2017	16.23	9.16	4.28	46.74	7.71	46.73	56.44	13.24	13.79
2018	18.18	9.64	4.49	48.67	7.45	46.58	53.03	14.30	13.43
Sign.	**	N.S	N.S	**	N.S	N.S	**	N.S	N.S
L.S.D. 5%	1.10	-	-	0.99	-	-	0.45	-	-
<b>Sowing dates (S)</b>									
15 April	17.05	9.45	4.45	48.24	7.42	47.09	55.47	13.89	13.73
15 May	17.16	9.75	4.34	48.15	7.48	44.51	56.86	14.10	13.49
15 June	17.30	9.21	4.29	47.56	7.61	46.58	53.59	13.50	13.54
15 July	17.35	9.19	4.47	46.89	7.89	48.63	52.97	13.66	13.68
Sign.	N.S	N.S	N.S	*	N.S	**	**	N.S	N.S
L.S.D. 5%	-	-	-	1.17	-	0.92	0.63	-	-
<b>Cultivars (C)</b>									
Brands	16.84	9.38	4.11	46.76	7.23	43.82	55.74	13.51	14.77
Dale	17.75	9.84	4.11	49.74	6.57	41.77	55.56	13.94	12.83
Honey	17.04	8.31	4.57	44.89	7.97	54.09	48.78	13.36	14.33
Leoti	17.35	9.60	4.29	48.45	9.17	44.69	55.30	13.87	12.85
Planter	17.30	9.06	4.58	47.43	8.58	50.05	52.36	14.14	13.76
Rex	16.74	9.80	4.15	47.31	7.19	42.35	58.55	13.93	14.28
Rio	17.36	9.55	4.44	48.14	7.55	46.49	55.00	13.98	13.02
Tracy	17.87	9.39	4.81	47.01	7.14	51.23	52.57	13.68	13.78
Umbrella	16.84	9.32	4.67	48.68	8.19	50.11	55.39	13.49	13.36
Williams	17.03	9.79	4.16	48.68	6.23	42.49	57.51	13.95	13.07
Sign.	N.S	N.S	N.S	**	*	**	**	N.S	**
L.S.D. 5%	-	-	-	1.59	0.42	1.28	1.05	-	0.48
<b>Interactions</b>									
YxS	N.S	N.S	N.S	*	N.S	**	*	N.S	N.S
YxC	*	N.S	N.S	**	N.S	**	**	N.S	*
SxC	N.S	N.S	N.S	**	N.S	**	**	N.S	*
YxSxC	*	N.S	N.S	**	*	**	**	N.S	*

differed among the four sowing date. The values of JEP were decreased gradually as sowing date delayed from April to July. On the contrary, syrup extraction percentage was insignificantly affected by sowing date (Table 2).

Juice purity and glucose ratio (GR) were markedly affected by sowing dates where, a gradual decrease in purity have been observed as sowing date delayed. Results also cleared that sowing in May significantly recorded the lowest GR value. Similar findings were reviewed by Besheit *et al.* (1996) and Al-Labbody *et al.* (2008).

Sowing dates insignificantly influenced the total fermentable sugars and stalk fiber percentage (Table 2). Such effect may be due to the insignificant effect on both sucrose and reducing sugars discussed before. Further, environmental factors prevailing in each season did not affect both traits. Insignificant differences were found between the two seasons in sucrose, reducing sugars, total fermentable sugars and fiber percentage as shown in Table (2).

Great variations in all processing parameters have been detected among the tested cultivars

except the total fermentable sugars percentage, where, slight differences among cultivars were observed (Table 2). Dale, Leoti, Umbrella and Williams with insignificant differences among them recorded the highest JEP. However, Honey followed by Brands exhibited the lowest JEP.

Regarding syrup extraction percentage (SEP), results in Table (2) indicated that SEP values ranged between 6.23% with Williams cultivar to 9.17% with Leoti cultivar.

Purity and glucose ratio (GR) were significantly different among the tested sorghum cultivars. The highest purity (58.55%) was in Rex cultivar followed by Williams (57.51%), corresponding to the lowest GR values recorded by the same mentioned cultivars, On the other hand, the lowest purity (48.78%) and the highest GR value (54.09%) were that of Honey cultivar. The reduction of purity values and the increase in GR values make sorghum juice potentiality more suitable for syrup industry and energy production, *via* decreasing operational problems for sugar crystallization (Besheit *et al.*, 2000; Al-Labbody *et al.* 2008; Amer and Besheit, 2016 and Besheit and Mekdad, 2016).

The combined results of 2017 and 2018 seasons and other seasons (not presented) demonstrated that total fermentable sugars (TFS) was insignificantly affected by the tested sweet sorghum cultivars (Table 2). Such effect may be due to the insignificance of the tested sorghum cultivars difference between sucrose and reducing sugars.

Otherwise, significant variations in fiber % have been observed among the tested cultivars. Their values fluctuated between 12.83% and 12.85% for Dale and Leoti and 14.77% and 14.28% for Brands and Rex cultivars, respectively. The other cultivars were between these limits.

### **3.4. Yields**

#### **3.4.1. Average stripped stalk weight per plant and stripped stalk yield/ feddan**

Combined results (Table 3) indicated that average stripped stalk weight/ plant and stripped stalk yield/ fed. were significantly influenced by sowing dates. Sowing in May exhibited the highest average stalk weight/ plant and stalk yield/ fed. followed directly by sowing in April (Table 3). Otherwise, delaying sowing significantly reduced both traits. These results gave evidence that growing conditions as sowing delayed up to harvest are apparently unfavorable in terms of temperature, day length and light intensity (Abdel-Gawad, 1981).

Moreover, higher values of various noticeable signs of pink stem borer associated with late sowing as mentioned before or with other words to the high borer insect attack sweet sorghum with delay sowing in comparison with early sowing. These findings are in full agreement with those of Almodares *et al.* (1994), Besheit *et al.*, (1996) and Al-Labbody *et al.*, (2008).

Combined results across 2017 and 2018 (Table 3) clarified that stripped stalk yield/ fed. significantly differed among the tested cultivars. Rio cultivar exhibited the highest stripped stalk yield/ fed. (27.47 ton) followed by Dale, Rex, Williams and Leoti cultivars (without significant differences), moreover, Honey cultivar yielded the lowest stripped stalk yield/fed. (21.86 ton). The observed variation in cultivars productivity was associated obviously with the recorded average stripped stalk wt (Table 3). Furthermore the variation among the studied cultivars with respect to both traits may be of genetic causes and/or due to interaction between cultivars and sowing dates (Galal *et al.*, 2002 and Mailafiya and Degri, 2012). Moreover, the degree of damage caused by pink stem borer and corn aphid significantly differed among the used cultivars and was greatly affected both trait as mentioned before. The obtained results are in line with those of Al-Labbody *et al.* (2008), El-Geddawy *et al.* (2014); Amer and Besheit (2016) and Besheit and Mekdad (2016) who stated marked differences among sorghum cultivars with regard to stalk yield and stalk components.

#### **3.4.2. Forage yield**

Forage yield is the contribution of green leaves, tillers, branches and inflorescences at harvest time. This component is very important due to the shortage of green feed during summer period, where, forage yield (f) insignificantly differed between both seasons over the sowing dates and cultivars. Meantime, combined results across of both seasons (Table 3) indicated that forage yield gradually and significantly decreased with delaying sowing from April which recorded the highest forage yield up to July which recorded the lowest forage yield. Such effect may be due to severe damage caused by pink stem borer and corn aphid accompanied delaying sowing. These results are in agreement with those reported by Almodares *et al.* (1994) and Besheit *et al.* (1996) who stated that May sowing exhibited the highest forage yield/ fed. as compared with April sowing or June sowing.

**Table (3): Effect of sowing dates and cultivars on productivity traits of sweet Sorghum (combined over 2017 and 2018 seasons)**

Factors	Aver. stripped stalk wt (g)	Stripped stalk yield (T/F)	Forage yield (T/F)	Juice yield (T/F)	Syrup yield (Kg/F)	EtOH (L/F)
<b>Years (Y)</b>						
2017	754	23.52	7.33	11.07	850.3	782.2
2018	1100	25.83	7.52	12.67	941.6	968.1
Sign.	**	**	N.S	*	**	**
L.S.D. 5%	89	1.67	-	0.60	86.40	67.1
<b>Sowing dates (S)</b>						
15 April	1055	25.93	8.12	12.93	957.4	937.1
15 May	1127	26.89	7.64	12.95	968.3	943.0
15 June	785	23.73	7.58	11.29	859.5	873.2
15 July	741	22.17	6.38	10.39	798.6	747.5
Sign.	**	**	**	**	**	**
L.S.D. 5%	75	1.15	0.32	0.57	96.14	95.20
<b>Cultivars (C)</b>						
Brands	897	25.10	7.49	11.47	846.7	848.7
Dale	945	25.89	7.94	12.96	840.0	970.2
Honey	759	21.86	6.20	9.83	780.3	699.1
Leoti	962	25.62	7.57	12.44	1043.4	982.0
Planter	897	23.89	7.10	11.58	1001.3	875.4
Rex	980	25.82	7.69	12.81	857.0	876.8
Rio	1139	27.47	8.91	13.04	1095.9	1022.7
Tracy	862	23.06	6.88	10.95	782.1	803.4
Umbrella	835	22.24	6.54	10.75	830.9	734.9
Williams	994	25.82	7.93	12.62	881.9	939.0
Sign.	**	**	N.S	**	**	**
L.S.D. 5%	92	2.31	-	0.71	28.7	93.2
<b>Interactions</b>						
YxS	**	N.S	N.S	*	*	*
YxC	**	**	N.S	*	**	*
SxC	**	**	N.S	**	**	*
YxSxC	**	**	N.S	**	**	*

Regarding the effect of cultivars on forage yield/ fed., combined results demonstrated that cultivars insignificantly differed in forage yield. Rio cultivar yielded the highest forage yield/fed. (8.91ton) followed by Dale, Williams, Rex and Leoti, while, Honey exhibited the lowest forage yield/fed. (6.20ton) followed by Umbrella and Tracy. These findings are agree with those of Besheit *et al.*(1996); Abd El -Karim *et al.* (1999) and Besheit and Mekdad (2016).

The first and second order interaction significantly affected average stripped stalk weight/ plant and stripped stalk yield/ fed.,

however forage yield showed vice versa trend (Table 3).

### 3.4.3. Juice and Syrup yields

Results in Table (3) indicated that juice and syrup yields gradually and significantly diminished as sowing date delayed to reach the minimum level at July sowing. Further, both traits were significantly higher at 2018 season as compared with 2017 season (Table 3). The reduction in both traits may be greatly related the effect of sowing dates on juice extraction %; stripped stalk yield and total soluble solids as mentioned before. These results are corroborate

those of Besheit *et al.* (1996) and Al-Labbody *et al.* (2008).

Sorghum cultivars significantly affected syrup yield as shown in both combined results (Table 3) and other years (not presented). Juice and syrup yield/ fed. were fluctuated between 9.83 and 13.04 t/fed. and 780.3 to 1095.5 Kg/fed. for Honey and Rio, respectively. The variation detected among the tested cultivars for both traits were markedly relates to JEP, SEP, stripped stalk yield and quality traits in addition to the tolerance and susceptibility of the used cultivars to pink stem borer and corn leaf aphids which measure by many constant parameters as discussed previously. These findings are in harmony with those of Mahmoud *et al.* (2013), El-Geddawy, *et al.* (2014) and Amer and Besheit (2016) who reported that sorghum cultivars potentiality varied greatly in juice and syrup yields.

#### **3.4.4. Ethanol yield**

Ethanol or bio-ethanol or bio-fuel is very important due to its utilization as natural source of free octane fuel beside its implement in other purposes. Therefore, use of agricultural resources rich and available carbohydrates could be easy fermented to ethanol production. Nevertheless, sweet sorghum juice, bagasse and grain could be used in implement this goal. The theoretical ethanol yield (EtOH) could be calculated according to Smith and Buxton (1993). In this connection, the present combined data (Table 3) illustrated that sowing dates on May and April maximized ethanol production /fed., with delaying sowing ethanol production gradually decreased to reach the minimum corresponding to July sowing. This tendency is correlated greatly to the total fermentable sugars (sucrose + reducing sugars) and juice yield accompanied to sowing dates. Al-Labbody *et al.* (2008) stated that early sowing increase the quantity of ethanol produced as compared with late sowing.

Ethanol yield/ fed. exhibited significant differences among sorghum cultivars in combined results across 2017 and 2018 seasons (Table 3) and other years (not presented). Ethanol yield ranged between 699.1 L/F for Honey cultivar and 1022.7 L/F for Rio cultivar. Six cultivars yielded more than their average 875.5 L/F. Such effect gives evidence that most cultivars under study had high efficiency in producing ethanol. Kresovieh and Henderlong (1984) reported the feasibility of sorghum for ethanol production. Moreover, Smith and

Buxton (1993) stated that sweet sorghum juice was a good substrate for ethanol production. Furthermore, the variations among sweet sorghum ability in ethanol production detected in this work were affirmed by Allam *et al.* (2001), Al-Labbody *et al.* (2008) and Besheit and Mekdad (2016).

The first and second interaction degree (Table 3) significantly affected ethanol yield production. Such effect gives evidence that ethanol production is greatly affected by both the used factors meantime may be due to the effect of juice quantity and quality on this trait

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### تقييم مقاومة الإصابة بدودة القصب الكبيرة ومن أوراق الذرة في أصناف الذرة السكرية والصفات الإنتاجية والتكنولوجية تحت أربعة مواعيد زراعة

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#### ملخص

تم إجراء تجربتان حقليةتان في محافظة الفيوم مركز طاميه - مصر ، خلال صيف موسمى 2017 و2018 لتقييم حساسية 10 أصناف من الذرة السكرية وهي Tracy ، Rio ، Rex ، Planter ، Leoti ، Honey ، Dale ، Brands ، Williams و Umbrella ، ومدى قابليتها للإصابة (تحت الظروف الطبيعية) بأخطر آفتين حشريتين وهما دودة القصب الكبيرة (*Sesamia cretica*) ومن أوراق الذرة (*Rhopalosiphum maidis*)، إضافة الي تقييم صفاتها الإنتاجية وصفات الجوده في اربعة مواعيد زراعة (منتصف ابريل، مايو ، يونيو و يوليو). كان التصميم التجريبي المستخدم في الموسمين هو القطع المنشقة مره واحده في اربعة مكررات. احتلت مواعيد الزراعة القطع الرئيسية بينما وزعت الأصناف توزيعا عشوائيا في القطع الشقية كما تم التحليل التجميعي للموسمين معا. أشارت النتائج الى أن علامات الضرر المعيرة عن الإصابة بثاقبة القصب الكبيرة وحشرة من أوراق الذرة قد ازدادت تدريجيا وبشكل ملحوظ مع تأخير ميعاد الزراعة. وأن زراعة الذرة السكرية في شهرى يونيو ويوليو سجلت أعلى إصابة بالحشريتين تحت الدراسة مقارنة بميعاد الزراعة المبكر (0 ابريل ومايو). وفيما يتعلق بعلامات الضرر المعيرة عن الإصابة، كان هناك إختلافات معنوية بين العشرة أصناف من الذرة السكرية حيث سجل الصنف Rio ، Dale و Williams أقل إصابة (أكثر تحملا للإصابة) بثاقبة القصب الكبيرة وحشرة من أوراق الذرة بينما كانت أعلى الأصناف قابلية للإصابة هم الصنف Honey و الصنف Umbrella حيث سجلا أعلى مقاييس للإصابة. أظهرت مواعيد الزراعة والأصناف أختلافات غير معنوية على صفات الجودة (المواد الصلبة الذائبة الكلية- نسبة السكر- سكريات المختزلة) بينما تأثرت معنويا نسبة إستخلاص العصير (JEP) و نسبة الجلوكوز (GR) والنقاوة (الصفات التكنولوجية) بمواعيد الزراعة المختلفة حيث إنخفضت قيم JEP و النقاوة تدريجيا مع تأخر ميعاد الزراعة وسجلت GR أقل قيمة عند الزراعة في مايو مقارنة بثلاث مواعيد الزراعة الأخرى اما باقى الصفات التكنولوجية لم تتأثر معنويا بمواعيد الزراعة المختلفة. كما أوضحت النتائج أيضا وجود اختلافات معنوية بين الأصناف في جميع الصفات التكنولوجية فيمعدا صفة السكريات القابلة للتخمر (%TFS). أظهرت النتائج أيضا ان الصفات الإنتاجية إنخفضت إنخفاضا تدريجيا مع تأخر ميعاد الزراعة لتصل الى الحد الأدنى في شهر يوليو. أوضحت البيانات المجمعه (موسمى 2017 و2018 ) ان وزن السيقان النظيفة ومحصول كلا من العيدان النظيفة و السيرب والإيثانول تأثروا معنويا بأختلاف الأصناف (معدا محصول العلف) وحقق الصنف Rio أعلى الصفات الإنتاجية بينما سجل الصنف Honey أقل الصفات الإنتاجية. وأن الأختلافات بين الأصناف لجميع الصفات الإنتاجية ارتبطت ارتباطا واضحا بمدى مقاومة وحساسية الأصناف لثاقبة القصب الكبيرة ومن أوراق الذرة والمقاسة بالعديد من المقاييس الثابتة. أثر التفاعل بين المتغيرين (مواعيد الزراعة، الأصناف) بشكل ملحوظ على معظم الصفات التي تمت دراستها ولكن بشكل عام، أظهرت أصناف Rio و Dale التي زرع في مواعيد الزراعة المبكرة أعلى إنتاجية وصفات جودة و أقل علامات الضرر المعيرة عن الإصابة بثاقبة القصب الكبيرة وحشرة من أوراق الذرة.

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