Direct Research Journal of Agriculture and Food Science
Vol. 9, Pp. 218-229, 2021
ISSN 2354-4147
DOI: https://doi.org/10.26765/DRJAFS72910751
Article Number: DRJAFS72910751

https://directresearchpublisher.org/drjafs/

Full-Length Research Paper

Impact of rice husk polymer composite application under deficit irrigation on productivity and stress tolerance of some sugarcane varieties

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Received 3 June 2021; Accepted 30 June 2021 Published 19 July 2021

ABSTRACT: The superabsorbent polymer composite based on rice husk (RPC) and loaded with urea (RPUC) as environmental-friendly products were evaluated on three sugarcane varieties productivity and stress tolerance under deficit irrigation in the greenhouse during 2019 and open-field during 2020/2021 at El-Sabahia Agricultural Research Station of Alexandria (31°, 13N latitude), Sugar Crops Research Institute, Agricultural Research Center, Egypt. Four levels of RPC or RPUC (0 (control), 1, 2, and 4gm) under three irrigation intervals (2,3, and 4 weeks) were carried out in the greenhouse. The data showed that water stress at 3 weeks irrigation interval has a negative effect and is non-significant on growth parameters when applied 2 g or 4 g of RPC and RPUC as well as increment of stalk characteristics. So, the composite levels were used for the field experiment. The treatment RPC and RPUC in the soil had a remarkable effect in improving all growth and quality parameters of sugarcane varieties at 3 weeks irrigation interval. Statistical analysis of RPC and RPUC has recorded the highest average cane yield in variety GT54-9 (52.89 ton/fed) followed by G2003-4 (43.62 ton/fed) then G2004-14 (34.88ton/fed). Application of 4g RPUC and 2g RPC significantly increased sugar yield by 64.53 and 46.04%, respectively as compared to untreated ones. Treatment with different RPC levels and 4g RPUC showed two positive marker bands at values Rf 0.86 and 0.93 which can be considered as indicated for drought-tolerant treated varieties. So RPC and RPUC can be utilized as effective means for the water deficit characterized locations.

Keywords: Composite, environmental-friendly, peroxidase, quality parameters

INTRODUCTION

The Egyptian government's strategies aim to enlarge the cultivated area and to guarantee sufficient production of the main crops but water management is one of the most important issues facing the world. Water deficit is caused by negative environmental aspects including losses in crop productivity. Recycling water-efficient and re-use of lignocellulose wastes as natural super absorbent polymers can be mitigated from the detrimental effects of drought on crop productivity and are potentially useful in the agricultural and environmentally sustainable planning of the future economy.

Sugarcane (*Saccharum officinarum* L.) an important agro-industrial crop is grown on 20.42 million-hectare area, with a production of 1,333 million tonnes worldwide (Ruan *et al*., 2018). In Egypt, sugarcane accounts for around 86 % of the sugar crops and around 50 % of the sugar production. The demand for sugar production is expected to increase to 203 million ton by the year 2028 due to population growth in MENA region that lead to increase sugar consumption and economic development. Irrigation and fertilization are the important factors affecting sugarcane production, occurring due to the failure of adaptation. It requires large quantities of water which around 400m^3 water/ton of sugarcane annually (Linstead *et al*., 2015). Previous research has shown that prolonged periods of reduced water availability have negative effects on sugarcane production and responses to nitrogen fertilization. Nitrogen is an essential element that is involved in physiological processes and influences plant growth. Urea is commonly used fertilizer worldwide thanks to its high content of nitrogen (46%), low cost, and ease of application but it can easily get lost in soil due to soil humidity and raising the temperature (Jones *et al.,* 2013). Additionally, stress-related genes and sugar transporter play a role in sucrose accumulation and the synthesis of proline. In the last few years, the country has been facing severe water shortages as the availability of water is decreasing due to the expansion of irrigated areas, growth in population, and urbanization (Khoso and Ansari, 2015). The plant can regulate the accumulation of reactive oxygen species when it is subjected to water stress by scavenging them with antioxidant enzymes such as peroxidases (Bano *et al*., 2013). The isozymes could be used as a biochemical marker to investigate plant stress tolerance (Zhang *et al.,* 2013).

Natural superabsorbent polymers are a type of polymers with strong water-absorbing capability, are effective in decreasing cumulative evaporation, may increase delivery the water, improving, enhance the physical properties and structure of the soil, increase photosynthesis efficiency and nutrients absorption of crops thereby increasing crop productivity under water deficit condition (Lejcuś *et al.,* 2018 and Satriani *et al.,* 2018). Jahan *et al.* (2019) stated that the addition 150 kg nitrogen plus superabsorbent polymers to hectare was the optimum rate for sustainable corn production, which improved water-use efficiency and maintains nutrient balance in the soil that increased plant biomass accumulation as well as the protein and sugar contents in the grain (Jahan *et al.,* 2017). However, the efficient management for superabsorbent polymers production from re-use organic wastes is essential to the reduction of environmental impact and lowering production costs. Rice agricultural wastes which have high lignocellulose, annual amounts range from 186–260 million tons in worldwide (FAO, 2016). Raw rice husk contains 74% organic constituents including cellulose, hemicellulose, lignin, and vitamins. The major inorganic component of rice husk is SiO_2 (80%) that reduces the deleterious effects of sugarcane under water deficit (Majeed *et al.,* 2017). Scientists are still working on finding out utilization of treating rice straw wastes that could be applied as a soil amendment to improve its physical properties and reduce water consumption by plants with improving photosynthetic efficiency under water deficit conditions (Feng *et al.,* 2020). Rashad *et al*. (2020) reported that amending soil with superabsorbent based on rice husk (1%) improved soil water retention, control the release of urea, and biodegradability.

A scientific group at the Faculty of Science, Tanta University synthesized a superabsorbent composite base on rice straw as eco-friendly sustainable superabsorbent composites to increase crop water productivity under drought conditions to maintain food security (Kenawy *et al.,* 2019). This composite was dissolved and slowly swollen in soil solution and transformed to hydrogel which could be a solution to the water management problem, particularly in arid areas. A superabsorbent composite with urea can play a role in reduce urea diffusion as a controlled release for nitrogen in the soil.

The present study was to evaluate the impact of different levels of the superabsorbent polymer composite based on rice husk (RPC) and loaded with urea (RPUC) on productivity improvement of some sugarcane varieties under deficit irrigation and reducing the effects of the water stress.

MATERIAL AND METHODS

Plant material and study location

Three sugarcane varieties were chosen namely GT54-9, G2003-4, and G2004-14. The experiments were carried out in greenhouse during 2019 and open-field during 2020/21 studies at El-Sabahia Agricultural Research Station of Alexandria (31°, 13N latitude), Sugar Crops Research Institute, Agricultural Research Center, Egypt.

Rice husk

The rice husk was dried in sunlight then it was ground using Los Angeles grinding machine and stored at room temperature in airtight polybag.

Rice husk polymer (RPC) composite

Rice husk polymer (RPC)and rice husk polymer with urea (RPUC) composite which prepared by the scientific group at Faculty of Science, Tanta University, Egypt, were a part of the project entitled: “Superabsorbent polymer composite for agricultural applications”(Funded by the Science and Technology Development Fund, STDF). According to the synthetic rice husk composite protocol, the (RPC) composite was prepared using 11.7% rice husk mill, 11.7% acrylamide, 6% gelatin and 0.6% N, N 0-methylene bisacrylamide (MBA) as a crosslinker with potassium persulfate (KPS) 1.0 wt% as an initiator. The RPUC was prepared using an amount of urea dissolved in distilled water with the same a weight of RPC composite (Kenawy *et al.,* 2019).

Experimental design

This study was carried out in completely random blocks design (RCBD) as follows

Green house and treatments as the primary experiment

To perform this study, the conducted primary experiment on the effect of different application rates of water and superabsorbent on yield. An experiment was carried out in the greenhouse during the season 2019 (February) to select the amount best of the tested composite that can be used to the response of sugarcane to drought stress in a clay sandy soil (prepared by mixing clay and sand with 2:1w/w).

Physicochemical analysis of the experimental soil showed that it contained total nitrogen 0.41phosphorus 4.9, potassium 53.9, magnesium 60.8, sodium 13.9, and chloride 8.9 mg/kg soil.

The pH of the soil was 7.2 and the EC was 3.5 mS/cm. The soil was placed in plastic pots (25 cm diameter, 50 cm depth) and was amended with (RPC) composite or RPUC at four rates including (0, 1, 2, and 4g) around the cane sett with three irrigation intervals (2, 3 and4 weeks).

Each treatment was done in three replicates and each replicate consisted of three pots after that the pots were irrigated.

NPKS fertilizers were applied as recommended by the Ministry of Agriculture and Land Reclamation of Egypt. The pots were left to grow under the normal growth conditions of the greenhouse (32/23°C ±2 day/night, day length 12–14 hours, relative humidity 66–73%). Stalk characteristics and total soluble solids as indicators of quality characteristics were recorded at different ages up to 8 months.

Field as the second experiment

The field study was carried out in February 2020. The rates of (RPC) composite or RPUC used with irrigation treatments were based on an earlier preliminary study in the greenhouse to determine the best and appropriate quantity to apply.

RPC or RPUC composite was incorporated into a depth of 10 cm of the topsoil. Canes were cut into three budded sets and planted in a single row each row was 5m long and 1.25m apart.

Standard planting and uniform all other agronomic practices were applied to all entries in the trial the field was irrigated right after planting.

Studied characters

Growth parameters: Stalk height (cm), cane diameter (cm), number of internode, and cane weight were recorded from randomly selected 10 stalks after 12 months of planting. Cane yield (ton/fad) was calculated based on cane stalk weight. Quality parameters: total soluble solids (%) was measured in the juice using a refractometer (20°C) ; chlorophyll was measured on 3rd expanded leaf from the cane top by CM-A Portable Chlorophyll Meter Reading, sucrose content was determined using UV at 210 nm according to the procedures by Mohamed and Higazi (2016); purity (%) was calculated based on sucrose (%) / ^{o}Brix; commercial cane sugars values (%CCS) and sugar yield (ton/fed) were calculated as follows CCS% = (1.022 × sucrose %) – (0.292 × ^{o}Brix) ; sugar yield (ton/fed) = stripped cane yield (ton/fed) × CCS (%) /100 according to the method of Meade and Chen (1977).

Peroxidase analysis

The young leaves (1gm) for each variety were prepared and homogenized with 3.5 mL of phosphate buffer (0.1 M, pH 7.0) and centrifuged at 12,000 rpm for 10 min as described by Johnson *et al*. (2012). Isozyme analysis for peroxidase was carried out according to Sadasivam and Manickam (1992). The gel after the electrophoresis was incubated in the staining solution containing 100 mg benzidine, 4.5 mL acetic acid, and 200 μL hydrogen peroxide until the clear bands appeared, then washed with distilled water and photographed using the gel documentation system

Statistical analysis

Statistical analysis of data was done using a Co-Stat Software (2004) computer program and Duncan's New Multiple Range Test (DNMRT) was used for testing the mean differences at a 1% probability level (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Impact of different levels of RPC composite with increasing the irrigation intervals on some parameters sugarcane varieties in greenhouse

The average plant height, cane diameter, and a number of nodes of the three studied sugarcane varieties concerning RPC and RPUC under different irrigation treatments at 8 months after sowing were showed in

(Figure 1). According to result of the analysis of variance at 1% probability level, the rate of RPC and RPUC application in the soil had a remarkable effect in improving an all growth parameters of the plant under different irrigation treatments. On the other hand, the mean comparison results of different irrigation regimes showed that there was a negative effect between the plant growth parameters and deficit irrigation or increasing irrigation interval (Figure 1).

Plant height

Plant height is one of the most important morphological parameters related to the growth and development of the crop. The mean comparison results of different irrigation regimes showed that the plant height was significantly ($p \leq 0.01$) reduced by 20.45, 11.48, 16.39, and 18.48% at 2, 4 ,6, and 8 months growth stages, respectively under the irrigation intervals every four weeks. Applying RPC or RPUC were significantly increased plant heights under different irrigation regimes (Table 1). Results demonstrated that the RPUC led to an increase markedly in plant height of sugarcane types grown under different irrigation treatments at the first 4 months with an average rate of 35.92, 49.66, and 42.90 % for dose 1, 2, and 4 g RPUC respectively compared with the untreated plant. The plant height continued to increase with lower rates in the following months as shown in (Table 1). The plant height growth rates in a plant grown in the RPC were slightly lower than in plant grown in the RPUC; it was 19.06%, 30.61%, 30.40% for 1, 2, and 4 g RPC, respectively compared with the untreated plant at age 4 month, under normal irrigation treatment (Table 1). Also, the application of 2g RPUC and 4g RPC with increasing irrigation intervals led to a 72.79% and 47.9% respectively at 4 weeks irrigation, increase in plant height in comparison with control (Figure 2 and Table 1). Under drought stress (every 3 weeks irrigation), the highest mean plant heights (162 cm) obtained from (2g) RPUC treatment followed by 4g RPUC treatment (149.33cm) and the lowest one (103.67cm) was for control at 8 months from planting (Figure 2).

Cane diameter

Statistical analysis showed that no significant differences were detected in the mean cane diameter of studied varieties between the irrigation interval of two weeks and three weeks (Fig.1). Increasing irrigation interval to four weeks had shown a significant decline of mean cane diameter by 27.27, 12.8, 18.72, and 16.25% at 2nd, 4th, 6^{th,} and 8th months after planting, respectively, comparison with irrigation interval of two weeks. Appling RPC and RPUC composite resulted in an increase in cane diameter under different irrigation intervals comparison with the controls. However, the mean cane diameter was increased significantly with increasing rates of polymer composite in all irrigation intervals. Soil amendment with 4g RPUC recorded the greatest means for cane diameter (2.71cm) followed with 2g RPUC (2.48cm) and 4g RPC (2.3cm) and the lowest means for cane diameter recorded in untreated control at 8months of planting (Figure 3).

Number of internodes

The comparison of the different rates of RPC and RPUC composite showed significant effects on internodes number under different irrigation intervals (Figure4-a). Increasing doses of tested composites improved internodes number during the first growth plant dependent on the application levels. As illustrated in Fig (4-b), the highest increase rate of internodes was achieved at two months of age in all treatments. This increase was a range from 2.99% in RPUC (4g) treatment to 2.17% in RPC (1g) as compared to untreated canes under every 2 weeks irrigation (Figure 4-b). After two months of growth, internodes number data showed a reduction of increase rate; the reduction values of all RPUC were slightly higher than that of RPC. However, there was no significant difference between applications of polymer composite with irrigation intervals every 2 weeks or 3weeks.

Total soluble solids (%)

However, significant variation (P<0.01) was observed due effect of RPC or RPUC composite on brix% in sugar cane varieties. The T.S.S (%) increased during growth stages until 8 months. Data recorded that the brix percentage increased gradually by increasing the rate of RPC or RPUC composite. The average T.S.S values were 14.1% and16.2 %, respectively, at the 6th and 8th months. These results indicated that RPC and RPUC application improve vegetative growth due to its effects in stimulating photosynthetic processes by increasing the organic and nutrient compounds (Kenawy *et al*., 2018), followed by active translocation of photo assimilates from source to sink tissues (Singh *et al*., 2018), improve water absorption capability in soil (Olson and Walsh, 2018). The rice husk polymer which has strong water absorption capability provided and promoted plant absorption of nutrient elements (Majeed *et al.,* 2017). It can be used as soil fertilities under deficit irrigation to enhance sugarcane yield and tolerance. From the above results selected RPC and RPUC at doses 2 and 4 g to apply in sugarcane

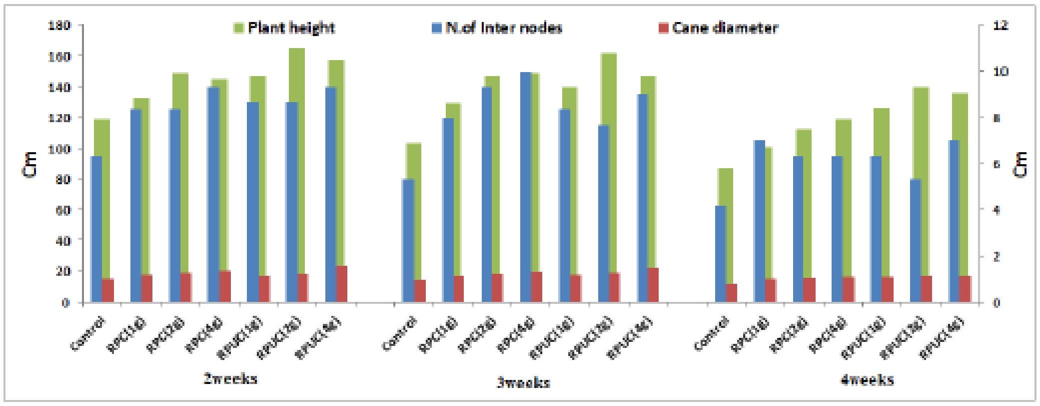

Figure 1: Variation in morphological parameters of studied sugarcane varieties used different rice husk polymer composite under different irrigation intervals.

Table 1: Mean comparison of increase rate of plant height (%) in sugarcane varieties during the period under application of rice husk polymer (RPC) or rice husk polymer with urea (RPUC) composite and different irrigation intervals.

Treatment		**Control (cm)**	**Increase rate (%)**					
			RPC			**RPUC**		
			1g	**2g**	**4g**	**1g**	**2g**	**4g**
Growth period (month)	2	44.78	18.11	32.74	41.67	30.64	51.36	51.85
	4	106.76	19.06	30.61	30.40	35.92	49.66	42.90
	6	140.22	14.26	21.95	30.67	21.00	28.22	24.33
	8	189.41	5.45	4.36	7.14	8.94	10.15	5.20
Irrigation intervals (week)	2	118.8	11.39	25.69	21.78	23.46	39.17	32.72
	3	103.67	25.08	41.48	44.04	34.73	56.27	41.8
	4	87	35.63	41	47.9	67.81	72.79	67.44

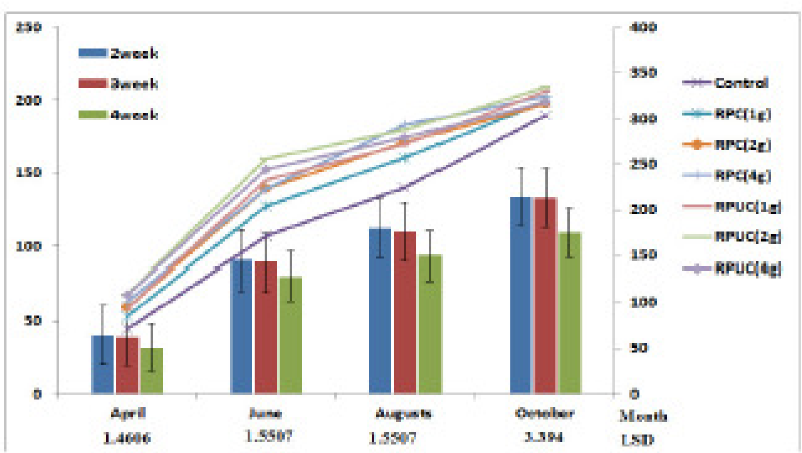

Figure 2: Effect of different doses of RPC and RPUC on sugarcane height during growth stages under different irrigation intervals.

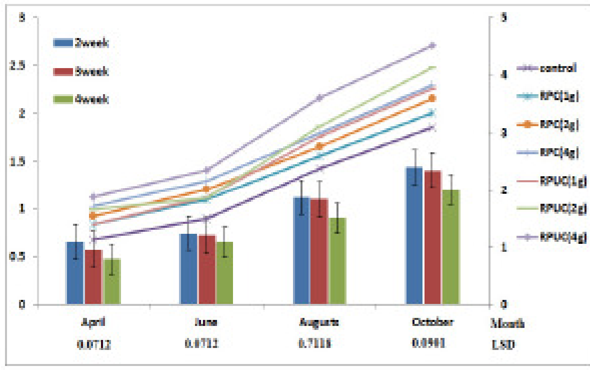

Figure 3: Effects of different doses of RPC and RPUC on stalk diameter under different irrigation intervals.

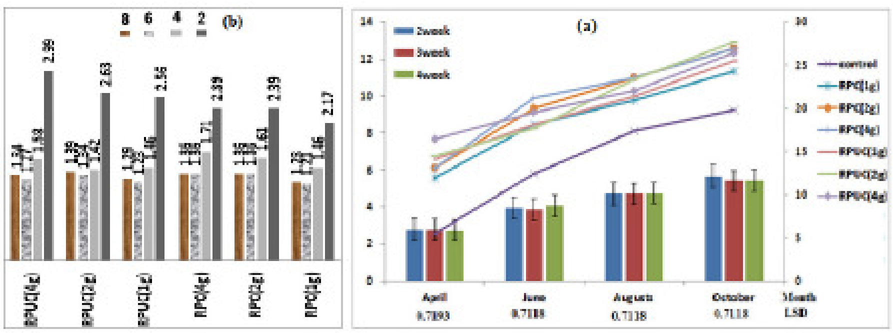

Figure 4: Mean comparison of increase rate of a number of internodes (%) in sugarcane varieties during the period under application of rice husk polymer (RPC) or rice husk polymer with urea (RPUC) composite.

planting in the field under irrigation intervals every 3 weeks.

Evaluate the effectiveness of rice husk polymer composite on sugarcane grown in the field with water deficit

The field experiment verified the applied selected RPC and RPUC levels in soil and was evaluated by the change of growth and juice quality parameters of tested sugarcane varieties under irrigation every three weeks during the 2020 season. Statistical analysis of different sugarcane varieties with composite doses was done as a result of all interactions in (Table 2). Mixing the rice husk as positive control and evaluated polymers composite with the soil had resulted in a pronounced enhancement of the morphological parameters and juice quality of the three studied varieties comparable with untreated plants (control).

Regarding the sugarcane varieties

Data in (Table 2) showed that sugarcane varieties had significant effect on all the studied traits by the experimental treatments depending on type and doses of composite. From the data of untreated sugar cane as control demonstrated that , the average highest of cane height (306.8 cm), cane diameter (2.06 cm), cane yield (44.08 ton/fed), T.S.S (18%) sucrose (12.96%) sugar yield (3.52 ton/fed) was obtained in variety GT54-9. The variety G2004-14 had the lowest values of cane diameter (1.78cm), internodes number (13.2), cane weight (545g) ,cane yield (28.73 ton/fed) and sugar yield (2.13ton/fed) but it showed higher values in cane height (279.4 cm),T.S.S. (15.5%) and sucrose (11.59%) than that of variety G2003-4 .Also, the data in Table (2) shows that there were significant differences in this studied parameters of different sugarcane varieties in soil amendment with different doses of RPC, and RPUC. Rice husk or RPC and RPUC were increased growth and

Table 2: Effect the rice husk polymer composite (RPC) and with urea (RPUC) ongrowth and juice quality parameters of sugarcane varieties under irrigation every three weeks.

Varieties	Treatment	Cane height (m)	Cane diameter (cm)	Internodes cane (no.)	Cane weight(gm)	Cane yield (ton/fed)	T.S.S (%)	Sucrose (%)	Purity (%)	N.S.S (%)	CCS (%)	Sugar yield (ton/fed)
	Control	266.4	2.04	17.6	650	32.79	13.5	10.64	78.82	2.86	7.03	2.31
	Rice husk	408	2.4	22.6	920	37.632	16	13.05	81.56	2.95	8.79	3.31
	RPC(2g)	282.4	1.74	20.6	690	43.39	15.5	11.91	76.86	3.59	7.74	3.36
G2003-4	RPC(4g)	262	1.9	14.2	560	44.08	14.7	11.99	81.56	2.71	7.96	3.51
	RPUC(2g)	317	1.72	18.6	770	50.69	14	10.59	75.64	3.41	6.82	3.46
	RPUC(4g)	325	2.14	20.4	820	53.14	15	12.21	81.40	2.29	8.35	4.437
	Means	310.13 b	1.99 b	19.17a	735 b	43.62 b	14.78 c	11.56 c	79.3 a	2.97c	7.76 c	3.39b
	Control	279.4	1.78	13.2	545	28.73	15.5	11.59	74.77	3.91	7.42	2.13
	Rice husk	330.6	1.92	13.6	680	32.66	17	14.36	84.47	2.64	9.84	3.21
	RPC(2g)	294.2	1.94	15.8	600	36.96	17	13.69	80.53	3.31	9.15	3.38
G2004-14	RPC(4g)	295	2.12	15.8	650	35.08	16	12.02	75.13	3.98	7.72	2.71
	RPUC(2g)	304.6	2	15.4	600	36.25	15	11.75	78.35	3.25	7.74	2.81
	RPUC(4g)	336.8	2.12	10.8	690	39.65	15	12.09	80.6	2.91	8.09	3.21
	Means	306.76 b	1.98 b	14.1 b	627.5 c	34.88c	15.92 b	12.58 b	78.97 b	3.33 b	8.33b	2.91c
	Control	306.8	2.06	12.2	650	44.08	18	12.96	72	4.04	7.986	3.52
	Rice husk	329	2.12	16.2	960	49.01	17.5	13.83	79.03	3.67	9.02	4.42
	RPC(2g)	316.8	2.02	15.2	920	55.78	18	13.69	76.05	4.31	8.74	4.88
GT54-9	RPC(4g)	321.6	2.1	13.4	910	55.03	16	12.59	78.69	4.41	8.19	4.5
	RPUC(2g)	339.8	2.2	14	945	55.7	18	13.98	77.67	4.02	9.16	5.07
	RPUC(4g)	329	2.12	15.6	950	57.79	18.5	14.38	77.73	4.12	9.42	5.44
	Means	323.83 a	2.1a	14.43b	889.17 a	52.89 a	17.67a	13.57 a	76.86c	3.26a	8.75a	4.64a

Means followed by the same letters do not differ significantly at 5 %level of probability.

juice quality parameters of tested sugarcane varieties under irrigation system. The increase of cane height was 19.70, 11.75 and 6.66 % in G 2003-4,G 2004-14 and GT54-9 respectively, compared to control where cane height is a major growth parameter and influenced by the variety (Minhas *et al.,* 2013). Therefore, cane height of GT54-9 increased from 306.8 to 316.8 , 321.6 and 339.8 and 329, in treatment 2g RPC , 4g RPC, 2g RPUC and 4g RPUC, respectively while rice husk treatment increased the cane height from 266.4 to 408 cm in G 2003- 4 under irrigation system (Table 2). This results confirm those of Yadav and Prasad (1992) and Srivastava and Yadav (2017) who found that incorporation of rice straw with urea increased about 34% of biomass of sugarcane due to provide a organic carbon and nitrogen content in soil. The productivity of sugar yield can be used as an indicator for drought tolerance of cane cultivars that recorded highest average (4.64 ton/fed) in GT54-9 followed by G2003-4 (3.40ton/fed) then G2004-14 (2.91ton/fed) under the same conditions. The genetic make-up of GT54-9 variety may be caused superiority of morphological parameters. The quality parameters of sugarcane may be depends on genetic potential and climatic variables (Cardozo and Sentelha 2013). The amount of chlorophyll in leaves is a good measure of stress tolerance (Li *et al.,* 2011). The average chlorophyll content ranged 27% in G2003-4 to 36.08% in G2004-14. It was increased by 36.08, 33.81 and 34.94% in G2003-4, G2004-14 and GT54-9, respectively when used evaluated composite under irrigation system. Chlorophyll contains Mg which maintains plant photosynthesis and can promote of crops growth and development (Chen *et al*., 2018). Superabsorbent polymers application increased of chlorophyll which improves mechanism of photosynthesis efficiency, as well as an increasing available water in the soil, which lead to rapid growth and increase in plant weight under water stress (Cannazza *et al.,* 2014 and Li *et al.,* 2018) reported that, super absorption polymer application increased the chlorophyll content of areca seedlings under M and D extreme drought content increases photosynthetic performance and plant stress tolerance. From the analysis, it can be possible GT54-9 recorded highest average in morphological characters and juice quality and

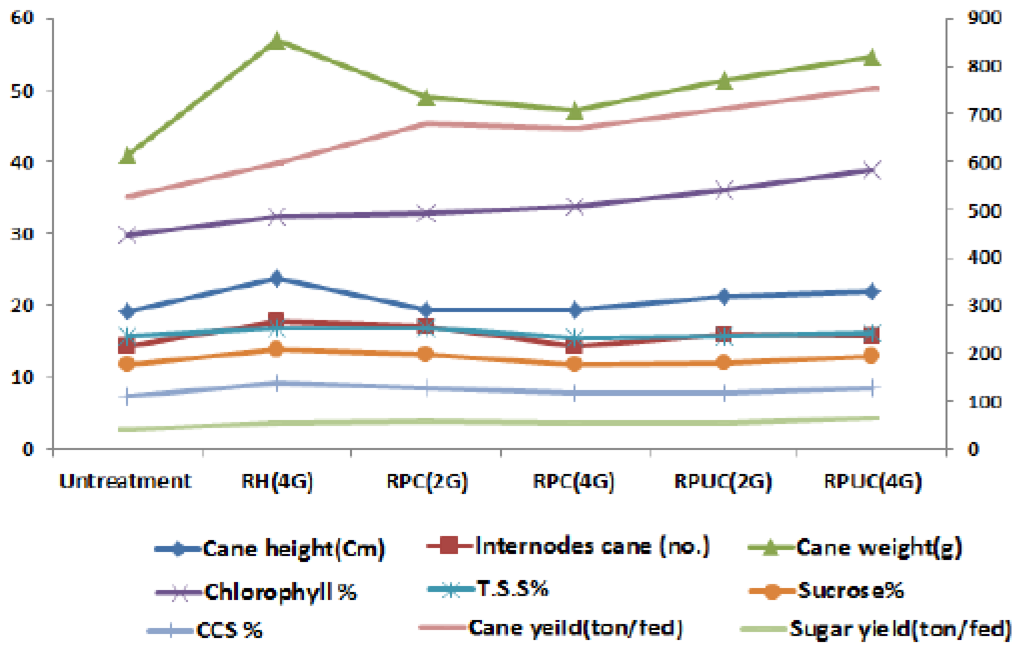

Figure 5: Growth and quality parameters of sugarcane as affected by the rice husk, rice husk polymer composite (RPC) and with urea (RPUC) under irrigation every three weeks.

as water-deficit tolerant variety followed by G 2004-14 then G 2003-4.

Regarding the growth and juice quality parameters of sugarcane

The data in Table 2 and Figure 4 demonstrated that the all RPC or RPUC treatments showed improved of all studied growth and juice quality parameters under irrigation every 3 weeks. The cane height of untreated varieties ranged from 266.4 cm in G2003-4 to 306.8 cm in GT54-9 and the average was 284.2 cm. The treatment rice husk (4g) and RPC or RPUC at dose 2g and 4g increased the cane height by 23.08%, 14.23%, 10.83%, 1.3 % and 0.87 % respectively. The results in Table (2) also indicate that the average cane diameter ranged from 1.78 cm for G 2004-14 to 2.06 cm for GT54-9 and the average was 1.92 cm. Application of different composite significantly increased cane diameter by about 9.69 and 8.67 % for RH and 4g RPUC treatment and was statistically equal with that of 2g RPC treatment while non-significantly increased for 2g RPC and 2g RPUC treatment. As it could be seen in Table 2, the average cane nodes of each treatment significantly increased by 24.21% (RH), 20.02% (2gRPC), 11.65% (2g RPUC), and significantly increased in 4g RPUC (1.27%) and 2g RPC treatment (0.91%). Results of cane weights and yields in response to different applied composites are presented in Table (2) and Figure (5). The average cane weight and yields in untreated soil were 615 gm and 35.2 ton /fed respectively. Under the same irrigation system, a significant increase was observed ($p \geq 0.05$) in cane weights and yields responding to applying RPC and RPUC in soil. Application of 4g RPUC significantly increased cane weights and yields by about 11.32 and 10.6%, respectively as compared to application of 2 g RPC and by 33.33 and 42.59%, respectively as compared to untreated ones (control). This may be due to supply of the sugarcane crop by nutrient elements in rice Husk, and reduced water loss in soil thereby preventing water deficiency and caused in better crop growth and increase crop yield (Li *et al.,* 2014). Rafiei *et al.* (2013) reported 200 $kg.ha^{-1}$ SAP on corn increased biological yield. Yousefian *et al.* (2018) found that the superabsorbent rice husk composite application improved canopy plant growth parameters. Kazempor and Zakernejad (2019) found that soil with super absorption polymer at 40 and 80 $kg.ha^{-1}$ increased sorghum plant leaf area and growth rate. Thus, rice is source of silicone which increased water use efficiency and increased photosynthetic activity (Mikhael *et al.* 2018). The response of the juice quality parameters T.S.S , sucrose, purity, N.S.S and CCS content in the presence and absence of RPC and RPUC are summarized in Table 2 which showed significant variations by different sugarcane varieties and evaluated composites. The highest T.S.S %, sucrose %, and CCS % were obtained by applying 4 g PRUC in GT54-9. The results of T.S.S (%) presented in (Figure 5) showed that the average highest percent of T.S.S (16.83 %) was obtained for 4 g RH treatment which statistically similar to that of 2g PRC (16.76%) and4g PRUC (16.17%) while the lowest T.S.S % (15.57 %) was observed for PRC(4g). Sucrose increases nitrate reductase gene expression and appears assimilation and transport nitrogen and balance carbon to nitrogen (Tognetti *et al*., 2013).

Table 2 demonstrates that the range of sucrose content in untreated varieties was from 10.64 % in G2003-4 to 12.96% in GT54-9. Application of rice husk (4g) significantly increased sucrose concentration by 17.22 %, following by 2g RPC (11.56%) then 4g RPUC (9.89%) treatment while the lowest increase rate of sucrose content was recorded in 2g RPUC(3.15 %) and 2g RPC treatment (1.19 %) . However, The RH treatment was found to produce the average highest purity (81.69%) followed by 4g RPUC (79.91%) and 4g RPC (78.46%) while the lowest purity was observed in 2g RPUC treatment. As shown from Table (2), RPC at dose 2g treatment had the highest N.N.S (4.41%) in GT54-9 while RPUC at dose 4g recorded the lowest N.N.S (2.29 %) in G2003-4. The sugars perform an imperative role to energy production, by cellular osmotic balance and regulation of gene expression to maintain their turgor pressure and metabolic activity. Application of super absorption polymer in the soil was allowed an increasing in the soil available water, which maintain a suitable osmatic status in the root and balanced metabolism to sustain normal growth under deficit water (Hoekstra *et al.,* 2001).

Tabulated data indicated that the highest CCS value was produced by the RH treatment following by 4g RPUC and then 2g RPC and the lowest percentages of CCS was recorded for 4g RPC and 2g RPUC (Figure 5).The sugar yield in response to different applied composites are presented in Table 2 and Figure (5). The average sugar yield ranged from 2.13 ton/fed in G2004-14 to 3.52 ton/fed in GT54-9. Application of 4g RPUC significantly increased sugar yield by about 64.53, 19.45, 12.66, 22.13 and 15.65% as compared to untreated ones, RH, 2g RPC, 4g RPC and 2g RPUC respectively under irrigation every 3 weeks (Figure 5). As presented in analysis, mixing of rice Husk at dose 4g with the soil recorded the highest mean in the all studied parameters except sugar yield content comparing with control (Table 2). This may be application of rice straw increased the organic carbon, potassium silicate and organic matter of the soil which has an important role in increasing photosynthesis rate and hence resulted higher in plant growth parameters (Yadav and Prasad, 1992).

The application of RPUC and RPC may be enhances the soil biochemical characteristics with increase soil the moisture content (Yang *et al.,* 2014), improve the adsorption and retention mechanisms of organic compounds (Majeed *et al.,* 2017) and increased sugarcane growth and productivity under deficit irrigation. The organic functional groups carried by rice husk is an important component of in plant cell elongation and division, regulation of enzyme activity, and can promote germination rate, and increase crop yield (Farhangi-Abriz and Torabian, 2018). From the results, considering the mean comparisons, the treatments could be arranged in a descending order as follows: 4g RPUC > 2gRPUC > 2g RPC > 4g RPC (Figure 5).

The isozymes as a biochemical marker to investigate plant stress tolerance

To characterize the tested sugarcane varieties on isozyme analyses of peroxidase were carried out in the plants treated with RPC, RPUC, RH and control. Peroxidase separation gel showed that three regions of peroxidase activity with four bands were observed in the enzyme system (Figure 6). Two common banding profiles were observed for all treated varieties and control; the first band at Rf value 0.061 and the second Rf value 0.44 (Table 3). Treatment with different RPC levels and 4g RPUC showed isoform band at value Rf 0.86 in G 2003-4 (V1), G2004-14 (V2), whereas GT 54-9 (V3) showed similar band at value Rf 0.86 with 2g RPC treatment and band at value Rf 0.93 for 4g RPC and RPUC treatments . On the other hand, no differences were observed in peroxidase bands of 2g PRUC treatment as compared to the control (Table 5). Study of isozyme banding profiles is one such significant and powerful method that has often been working to unravel the concealed variation and identify the genetic markers associated with drought tolerance in sugarcane varieties (Smila *et al.,* 2007). As illustrated in Figure 6, number and density of peroxidase banding patterns were differenced among treated varieties and control in cathodal side. The intensity of peroxidase banding patterns varied among all the treatment depended on different tested composite levels in anodal side which increased in 2g RPC and 4g RPUC treatment compared to the other treatment. Similar results were reported by Johnson *et al.* (2012) found that the appearance of isoperoxidase marker bands (0.62, 0.66) in resistant and stress tolerant varieties of sugarcane. Anbazhagan *et al.* (2009) explained the disease resistant clones using peroxidase isoforms and the existence of two bands at Rf values 0.537 and 0.694 as marker. Smila *et al.,* (2007) where they distinguished the appearance and disappearance peroxidase pattern due to differential activation of genes which synthesized of these enzymes at different stages. According to Majidi *et al*.

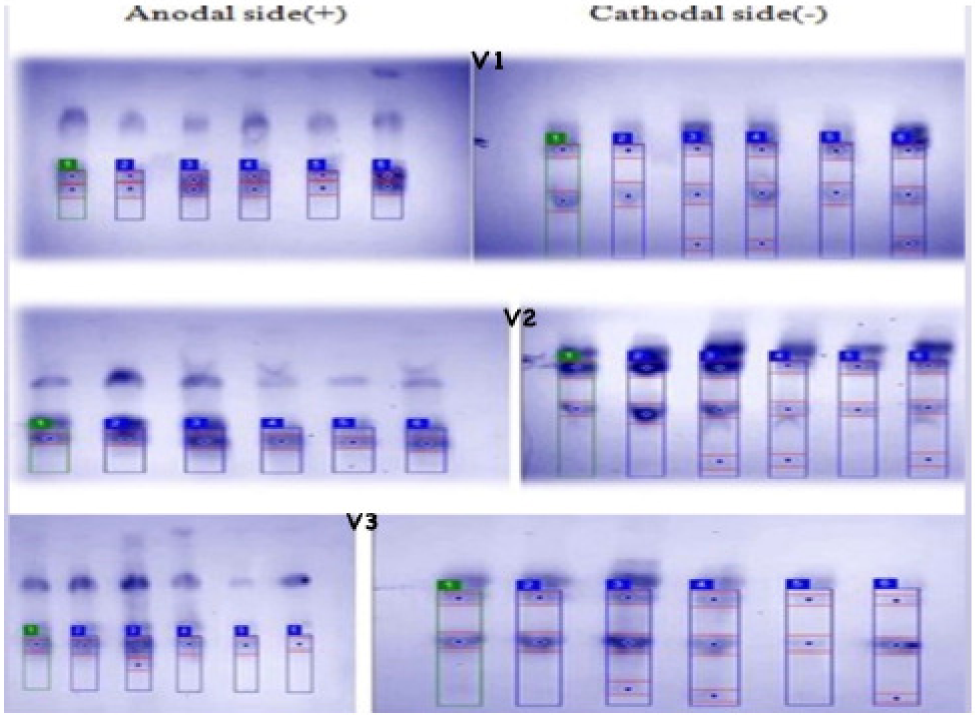

Figure 6: Isoperoxidase banding pattern for samples from all genotypes of sugarcane as affected by the rice husk, rice husk polymer composite (RPC) and with urea (RPUC) under irrigation every three weeks.

Table 3: MW- Rf values and banding profile of sugarcaneas affected by the rice husk (RH) , rice husk polymer composite (RPC) and with urea (RPUC) under irrigation every three weeks.

Treatment	**Control**			**RH**			**2gm RPC**			**4gm RPC**			**2gm RPUC**			**4gm RPUC**		
Varieties Mw-Rf	**V1**	**V2**	**V3**	**V1**	**V2**	**V3**	**V1**	**V2**	**V3**	**V1**	**V2**	**V3**	**V1**	**V2**	**V3**	**V1**	**V2**	**V3**
0.061	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0.44	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0.86	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	+	+	-
0.93	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+

(2015) who suggested that genotypes have moderate to high heritability estimates maybe have improved adaptation to the conditions under the deficit irrigation regime. Also, Li *et al.* (2018) who suggested superabsorbent polymer can develop the protection of plant leaves against drought stress by regulating the activity of peroxidase as a main member of protective enzymes.

The isozymes as useful markers can be used in genetic studies of many plant species plants and drought tolerance in sugarcane varieties defined morphological and physiobiochemical characteristics related to tolerance under natural field conditions and could be responsible of adapt to external stimulus for varieties (Allison and Schultz, 2004). From the aforementioned results, the positive markers (value Rf 0.86 and 0.93) can be considered as indicator for drought tolerant treated varieties and still needs further studies. The results obtained can be used in selection of more drought-tolerance sugarcane verities that can be cultivated in the new reclaimed land.

CONCLUSION

From the mean comparisons and the relationships among parameters in study, it could be recommended that the application of RPUC and RPC in soils reduced the effect of limited water stress and improved the negative effects under deficit irrigation intervals.

Acknowledgement

The authors are thankful to Prof. Dr Mohamed A. Ghonema, Prof. of Genetics and Plant Breeding, Sugar Crops Research Institute, Agricultural Research Center, Egypt for his valuable help in peroxidase analysis.

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