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Growth, yield and fruit quality of specialty banana in response to yeast extract and potassium amendments

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ABSTRACT

Nutrient and bio-stimulant amendments are important for growth, yield, and quality of fruit crops under environmentally stressed site conditions. Our field study was conducted to evaluate the effect of potassium fertilization and yeast extract on growth, yield and finger quality of banana grown under arid and semi-arid marginal site conditions in Egypt. Using different levels of Potassium at 500 & 1000 mg as a foliar application and yeast extract at one & two liters per plant as a drench soil application and their combinations doses added monthly six times during the period from October to March. The obtained results showed a positive correlation between the values of the studied parameters (growth, productivity and fruit quality) and the yeast and potassium levels. As a result, the parameters values increased as the yeast and the K_2SO_4 levels increased to a higher level during the two growing seasons. Herein, yeast extract 2000 ml + K_2SO_4 1000 mg/l/plant was statistically the superior. In addition, yeast extract 2000 liters + K_2SO_4 500 mg/l/plant statistically ranked 2nd after the above-mentioned superior treatment. On the contrary, the lowest values of these parameters were obtained by Control yeast extract 1 liter/plant. The remaining treatments have occupied an intermediate position between the treatments mentioned above in both seasons.

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Arid climate; bio-stimulant; finger quality; Grand naine; Yield

Introduction

Bananas are a tropical fruit crop that perform best within 20° of the equators, with a small variation in night and daytime temperatures subtropical climates. One of the most specialty bananas is exclusive Grand nan Cv. grown in Egypt. In recent years, research trials have been on-going to develop sustainable management practices to achieve economic yield and improved fruit quality of banana. Appropriate management practices such as balanced chemical fertilization and biological amendments are expected to improve plant physiology and vegetative growth which subsequently influence banana yield and fruit quality (Yeshitela, Robbertse, and Stassen 2004).

Potassium (K) is one of the essential macronutrients plays important roles in growth and yield of plants Prajapati and Modi (2012). It is essential for photosynthesis and sugar translocation, plant lodging tolerance, and cell division and expansion for fruit development (Mirza et al. 2018). Cell division and extension are key processes that regulate fruit size, controls water and nutrient uptake, by regulating stomatal functions. Stomata are the critical component on the leaf that

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Table 1. Weather data on air temperature, rainfall, and relative humidity of the study area, Khattatba, Sadat city Mounfia, Egypt during (2017–2018 growing years and long-term data).

	Year Months											
Air Temp. C°	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2017	13.4	14.3	16.7	19.7	24.3	26.5	27.3	27.4	25.5	22.8	18.7	14.4
2018	13.3	14.3	16.6	19.8	24.3	26.5	27.2	27.4	25.6	22.8	18.6	14.5
Long-term aver. C°	13.35	14.3	16.65	19.75	24.3	26.5	27.25	27.4	25.55	22.8	18.65	14.45
Rainfall (mm)												
2017	5.0	6.0	2.2	2.0	2.2	0	0	0	0	2.0	10.1	11.0
2018	4.9	6.1	2.1	2.0	2.1	0	0	0	0	2.1	10.2	11.0
Long-term aver.	4.95	6.05	2.15	2.0	2.15	0	0	0	0	2.05	10.15	11.0
R.H. (%)												
2017	61	62	59	49	46	49	58	61	60	60	61	61
2018	59	54	53	51	48	51	58	63	62	62	63	63
Long-term aver.	60	58	56	50	47	50	58	62	61	61	62	62

Source: Meteorological Station of, Mounfia, Egypt.

allow gas exchange in photosynthesis and the translocation the water from the roots upward to the leaves, translocate photosynthates and sugars from leaf to the fruit. In soil-plant ecosystems, K is very soluble, movable and absorbed during the vegetative growth periods especially more before bunching (Robinson and Galán 2010) and Abd El-Latif et al. (2020). Previous studies reported that balancing K fertilization is very important to influence growth, nutrition, fruit yield and quality of banana (Abdalla 2014; Ahmed et al. 2014; Ibrahim and Al-Wasfy 2014; Roshdy 2016). In recent years, use of bioinoculants is getting attention to improve metabolic functions, growth, and yield of crops (Mirza et al. 2018). Yeast extract is a natural bioactive recommended having stimulating, nutritional and protective purposes when used on banana. Several studies reported that yeast extract increased growth, yield and quality of many pomology crops (Abou EL-Nasr et al. 2001). Increased response in crop growth and yield by yeasts was suggested to be enriched source of phytohormones (Auxin and cytokinins), vitamins, enzymes, amino acids, gibberellins and minerals (Barnett, Payne, and Yarrow 1990; Fathy and Farid 1996; Khedr and Farid 2002; Abo EL-Fadl et al. 2017). Furthermore it is reported stimulatory effects of yeast on cell division and extension, protein and nucleic acid biosynthesis as well as chlorophyll formation (Roshdy 2016). Also, Abd El-Latif et al. (2020) using different potassium sources increased Banana yield and finger properties. Our hypothesis is that integration of balanced K fertilization with yeast extract will improve metabolic functions, growth, yield and quality of banana. To address the hypothesis, the objective of our research was to evaluate the effects of K fertilization with- and without inoculation of yeast extracts on growth, yield and finger quality properties of banana Grand nan cv. grown under irrigated desert condition.

Materials and methods

Site conditions

This study was carried out at El-Khattatba [30.24 N latitude and 30.33 E longitude] of Sadat city, Mounfia Governorate, Egypt at an altitude of 28 m above mean sea level. The area is under desert climate characterized as arid with mean annual monthly temperatures ranging between13.4 °C and 27.4° C (Table 1). There is a wide contrasting difference between the mean annual evaporation (4750–4800 mm) and the mean annual rainfalls (5–11 mm). Irrigation is the primary requirement for crop production.

Soil texture is a sand with 8% clay, 6% silt, and 86% sand. Soil has pH 8.2, electrical conductivity (ECe) 0.84 dS/cm, $CaCO_3$ 0.63%, exchangeable Na 29.1 mg/kg, K 1 mg/kg, Ca 12.4 mg/kg, Mg 8.6 mg/kg, Cl 15.3 mg/kg, and SO_4 6.3 mg/kg.

Experimental design

The field experiment was established in a randomized complete block design with three replications. The replicated size was … m long x ….m wide. Treatments were foliar spraying of K and application of yeast extract to the soil. Treatments were imposed 6 times per year starting in October and at month intervals.

1. Recommended doses (RD), the recommended NPK fertilization was 800, 100, and 1000 N, P_2O_5, K_2O g/plant as ammonium nitrate, phosphoric acid and potassium sulfate, respectively [Control].
2. RD + yeast extract @ 1 liter/plant [$Yeast_{1000}$]
3. RD + yeast extract @ 2 liter/plant [$Yeast_{2000}$]
4. RD + K_2SO_4 @ 500 mg/l/plant [K_{500}]
5. RD + K_2SO_4 @ 1000 mg/l/plant [K_{1000}]
6. RD + yeast extract @ 1 liter/plant + K_2SO_4 @ 500 mg/l/plant [$Yeast_{1000}$+K_{500}]
7. RD + yeast extract @ 1 liter/plant + K_2SO_4 @ 1000 mg/l/plant [$Yeast_{1000}$+K_{1000}]
8. RD + yeast extract @ 2 liter/plant + K_2SO_4 @ 500 mg/l/plant [$Yeast_{2000}$+K_{500}]
9. RD + yeast extract @ 2 liter/plant + K_2SO_4 @ 1000 mg/l/plant [$Yeast_{2000}$+K_{1000}].

Yeast extract preparation

Yeast extract, based on Saccharomyces cerevisiae spp., was prepared using a technique that allowed yeast cells (pure active dry yeast 100 gram/liter) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions that allowed to produce denovo beneficial constituents (carbohydrates, sugars, proteins, amino acids, fatty acids, vitamins, hormones, etc.) then these constituents could be released out of yeast cells in readily form by two cycles of freezing and thawing for disruption of yeast cells and releasing their content. Such a technique for yeast preparation was modified after (Spencer, Dorothy, and Smith 1983). Chemical analysis of yeast extract according to (Abou El-Yazied and Mady 2011), is presented amino acid% Alanine 1.69, Arginine 1.49, Aspartic acid 2.32, Cystine 0.63, Glutamic acid 3.76, Glycine 1.45, Histidine 0.71, Isoleucine 0.85, Leucine1.91, Lysine 1.13, Phenylalanine 1.18, Proline 1.29, Serine 1.98, Threonine1.54, Tryptophan 0.25, Tyrosine0.99, Valine1.4, Methionine 0.4, Vitamins (mg/100 g DW) Vit. B 123.33, Vit.B2 21.04, Vit.B6 20.67, Vit. B 12 19.17, Thiamin 23.21, Riboflavin 27.29, Inositol 20.43, Biotin 20.04, Nicotinic acid 73.92, Panthothenic acid 38.43, P aminobenzoic acid 29.49, Folic acid 26.22, Pyridoxine 22.09, Growth regulators ppm Adenine 31, Betaines 56, Minerals Nitrogen 6.88%, Phosphorus 0.66%, Potassium 0.95%, Magnesium 0.19%, Calcium 0.17%, Sulfur 0.48%, Iron 107 ppm, Zinc 77 ppm, Copper 5 ppm, Manganese13 ppm and Others Crude Protein 43%, Crude Fat 2.2%, Carbohydrates 33.2%, Crude Fiber7.2% and Ash 3.8%.

Cultural practices

Over the two successive growing seasons 2017 (first Raton plants) and 2018 (second Raton plants) of Grande Naine cv. [Giant Cavendish AAA subgroup], the mother plants were planted in March 2016 and three suckers were randomly selected for each mat (hole) and the others were removed. The plants were received compost at the rate of 60 m^3/acre/year within the root zone during the 1st week of December 2016. the recommended NPK fertilization was 800, 100, and 1000 N, P_2O_5, K_2O g/plant as ammonium nitrate, phosphoric acid and potassium sulfate, respectively. Well-water was used drip irrigation. Routine horticultural practices were followed to maintain the experiment. All these recommended practice were repeated for the two growing seasons.

Banana growth, yield and fruit quality

Morphological characteristics of banana plants were determined at bunch shooting stage for pseudo stem height, pseudo stem circumference, number of green leaves per plant, and leaf area. Bunch length and circumference, bunch weight, number of hand/bunches, and number of finger/hands were counted and recorded.

Finger weight, length and diameter, pulp weight, peel weight, pulp: peel, total soluble solids (TSS), total sugars, starch, titratable acidity, and TSS: acidity were measured on randomly selected mature fruits in each bunch. Total sugar and titratable acidity were determined by following standards methods of A.O.A.C. Association of Official Agricultural Chemists (AOAC)) (1995). The TSS was measured by digital hand refractometer as brix. Banana yield was calculated using the following equation:

$$\text{Yield } (\text{kg/ha}) = \text{Bunch weight (kg) x Number of plant/acre.}$$

Leaf samples were taken from the third upper leaf in the descending foliar succession of the banana plant after bunch shooting (Hewitt 1955; Saad and Atawia 1999). Total nitrogen was determined using the micro-Kjeldahl method (Pregl 1945). Phosphorus was determined according to the colorimetric method (Truoug and Meyer 1929). Potassium was determined according to the photometric method (Brown and Lilleland 1955).

Statistical analysis

Multivariate statistical analysis was performed to analyze the data using ANOVA (CROPSTAT 2007.2) program. Significant differences in the dependent variables (banana growth, yield and fruit quality) in response to the effects of predictor variables (K fertilization and yeast extract) were evaluated by one-way analysis of variance. The predictor variables were considered as fixed effects, but the block was considered as a random effect. Treatment means were separated by F-protected Duncan Multiple Range Test (DMRT) at $p \leq 0.05$, unless otherwise mentioned.

Results and discussion

Vegetative growth

All the vegetative growth parameters of Grande Naine banana plants were significantly affected by the K fertilization-yeast extract treatments in both seasons (Table 2). In other words, a positive response was observed between vegetative growth of banana and the levels of yeast extract and K fertilization. The effect of yeast and K on banana was consistently higher at maximum level of yeast extract and K in both growing seasons. However, the tallest plant and the thickest pseudo-stem were observed in Yeast $_{2000}$ ml/l + K_{1000}, followed by Yeast $_{2000}$ ml/l + K_{500} mg/l in both seasons. In addition, the highest number of green leaves/plant was (13.6 and 14.33) recorded by RD + Yeast Extract $_{2000}$ ml/l + K $_{1000}$ mg/l/plant during the first and second growing seasons, followed by RD + Yeast Extract $_{2000}$ ml/l + K 500 mg/l/plant leaves and RD + Yeast Extract 1000 ml/l + K 1000 mg/l/plant during 2017 and 2018 seasons. Whereas the highest leaf number was registered by RD + Yeast Extract 2000 ml/l + K 1000 mg/l/plant, followed in descending order by RD + yeast extract at 2000 ml/l + K at 500 mg/l and RD + yeast extract 1000+ K 1000 treatments in the two growing seasons. In contrast, the lowest values of these parameters were obtained by Control (Recommended Doses) and RD + Yeast Extract 1000/plant during the two seasons. The remaining treatments have occupied an intermediate position between the treatments mentioned above in both seasons.

Improved vegetative growth of banana was due to the stimulatory and positive effects of yeast extracts to enhance cell division and elongation of plants, which subsequently attributed to

Table 2. Effect of yeast extract and potassium on some vegetative growth characteristics of Grande Naine banana plants during 2017 and 2018 seasons.

	Plant height (cm)		Pseudo stem circumference (cm)		No. green leaves \plant at shooting time		Leaf area (m^2)	
Trts.	2017	2018	2017	2018	2017	2018	2017	2018
T1: Control (Recommended Doses)	245.33H	243.33H	72.17F	71.63G	11.67B	12.00C	1.41I	1.43I
T2: RD + Yeast Extract 1000 ml /plant	254.00G	251.00G	74.10E	72.99G	12.33AB	12.67BC	1.48H	1.48H
T2: RD + Yeast Extract 2000 ml /plant	259.33F	259.00F	75.27E	75.47F	12.33AB	13.33AB	1.54G	1.54G
T3: RD + K 500 mg/l /plant	265.33E	264.67E	78.05E	77.77E	12.33AB	13.33AB	1.63F	1.60F
T5: RD + K 1000 mg/l /plant	269.33D	270.00D	81.59D	80.63D	12.67AB	13.33AB	1.72E	1.69E
T6: RD + Yeast Extract 1000 ml + K 500 mg/l /plant	274.33C	273.67D	84.93B	83.00C	12.33AB	13.33AB	1.80D	1.78D
T7: RD + Yeast Extract 1000 ml + K 1000 mg/l /plant	278.67B	277.67C	85.70B	84.07C	13.33A	13.67AB	1.85C	1.84C
T8: RD + Yeast Extract 2000 ml + K500 mg/l /plant	282.00B	281.67B	91.18A	86.53B	13.33A	13.67AB	1.89B	1.89B
T9: RD + Yeast Extract 2000 ml + K 1000 mg/l /plant	286.10A	288.00A	91.19A	89.43A	13.6A	14.33A	1.97A	1.98A

Values within each column, followed by the same letter/s are not significantly different at 5% level.

increased water- and nutrient by plants. El-Boray (2015) reported that the positive role of yeast extract as one of the bio-stimulants is due to its effect on mineral nutrients, amino acids and growth promoting compounds. It also contain proteins and several vitamins which play a key role in improving growth and development, growing healthier plants and increasing yield and fruit quality (Barakat, Yehia, and Sayed 2012).

The stimulatory effect of K fertilization on banana growth and yield was due to improved respiration and photosynthesis activities. Several studies reported that K fertilization catalyzed the plant critical metabolic responses such as respiration, photosynthesis, chlorophyll formation, water regulation, and transportation and accumulation of sugars in the fruit (Mengel and Kirkby 1987; Mengel 1997; Yao et al. 2009). These results regarding the outcome of potassium on enhancing growth characters agree with those obtained by Haohash and Abd El-Nasser (2010) and Sathappan, Sivanesh, and Dhanasekaran (2019).

When combined, the yeast extract with K fertilization significantly improved the vegetative growth, which was attributed to their synergistic effects on metabolic processes and functions of banana plants.

Nutrient uptake

In this regard, leaf chemical analysis i.e., N, P, and K contents of Grande Naine banana plants as an indicator for nutritional status of plants which influenced by the differential investigated treatments were the concerned leaf mineral composition under study. Data obtained during both 2017 & 2018 experimental seasons are presented in Table 3. Herein, RD + Yeast Extract 2000 + K 1000 mg/l/plant was statistically higher in N and K contents in both study seasons. In addition, RD + Yeast Extract 2000 + K 500 mg/l/plant statistically ranked 2nd after the above-mentioned superior treatment in leaf N and K contents. Other treatments under investigation could be arranged downwards on their efficacy as follows: RD + yeast Extract 1000 + K1000 mg/l/plant, RD + yeast Extract 1000 + K 500 mg/l/plant and RD + K 1000 mg/l/plant. This trend was true during the experimental seasons of 2016 and 2017. On the contrary, the highest P value was recorded by Control (Recommended Doses) and RD + Yeast Extract 1000/plant during both study growing seasons of the lowest values in leaf N and K contents during both seasons of study.

Increased nutrient contents (i.e., NPK) in banana leaf could be attributed to the beneficial effects of K fertilization and yeast extract on absorption and accumulation of mineral elements in different plants. El-Boray (2015) reported that adding yeast extract significantly increased nutrient

Table 3. Effect of different treatments on leaves contents of N, P and K of Grande Naine banana plants during 2017 and 2018 seasons.

Parameters / Treatments	N (%)		P (%)		K (%)	
	2017	2018	2017	2018	2017	2018
T1: Control (Recommended Doses)	2.94E	2.93F	0.249A	0.247A	3.67I	3.34I
T2: RD + Yeast Extract 1000 ml /plant	2.99DE	3.05D	0.242B	0.241B	3.42H	3.39H
T2: RD + Yeast Extract 2000 ml /plant	3.02CDE	3.09C	0.235C	0.232C	3.45G	3.43G
T3: RD + K 500 mg/l /plant	3.09BCD	2.95F	0.230D	0.227D	3.51F	3.49F
T5: RD + K 1000 mg/l /plant	3.11BC	3.01E	0.214F	0.214F	3.54E	3.54E
T6: RD + Yeast Extract 1000 ml + K 500 mg/l /plant	3.12ABC	3.09C	0.209G	0.210G	3.60D	3.60D
T7: RD + Yeast Extract 1000 ml + K 1000 mg/l /plant	3.14AB	3.12BC	0.222E	0.221E	3.65C	3.65C
T8: RD + Yeast Extract 2000 ml + K500 mg/l /plant	3.18AB	3.14B	0.213F	0.212FG	3.72B	3.71B
T9: RD + Yeast Extract 2000 ml + K 1000 mg/l /plant	3.23A	3.20A	0.203H	0.203H	3.91A	3.86A

Values within each column, followed by the same letter/s are not significantly different at 5% level.

Table 4. Effect of yeast extract and potassium treatments on the period from shooting to harvest (days), bunch weight (kg), yield (ton/feddan) hand weight (kg) of Grande Naine banana plants during 2017 and 2018 seasons.

parameters / Treatments	Period from shooting to harvest (days)		Bunch weight (Kg)		Yield (ton/feddan)		Hand weight (kg)	
	2017	2018	2017	2018	2017	2018	2017	2018
T1: Control (Recommended Doses)	120.33A	120.00A	23.99G	24.60G	28.78G	29.52G	1.28H	1.31E
T2: RD + Yeast Extract 1000 ml /plant	118.67A	118.33AB	24.64FG	25.55F	29.54FG	30.66F	1.35G	1.36DE
T2: RD + Yeast Extract 2000 ml /plant	115.67B	116.33BC	25.44EF	25.60F	30.53EF	30.72F	1.41F	1.42D
T3: RD + K 500 mg/l /plant	115.33B	115.0C	26.15DE	26.32E	31.38DE	31.58E	1.42F	1.42D
T5: RD + K 1000 mg/l /plant	113.67B	114.CD	26.61CDE	27.45D	31.93CDE	32.94D	1.52E	1.50C
T6: RD + Yeast Extract 1000 ml + K 500 mg/l /plant	111.33C	111.67DE	27.29BCD	28.20C	32.74BCD	33.84C	1.56D	1.54C
T7: RD + Yeast Extract 1000 ml + K 1000 mg/l /plant	110.33CD	110.67E	27.70ABC	28.47C	33.24ABC	34.16C	1.62C	1.66B
T8: RD + Yeast Extract 2000 ml + K500 mg/l /plant	109.0DE	109.33E	28.22AB	28.97B	33.86AB	34.76B	1.71B	1.70B
T9: RD + Yeast Extract 2000 ml + K 1000 mg/l /plant	107.33E	108.67E	28.62A	30.05A	34.34A	36.06A	1.73A	1.82A

Values within each column, followed by the same letter/s are not significantly different at 5% level.

contents in orange trees. Our results concerning the consequence of K on enhancing absorption and accumulation of mineral elements agree with other studies (Haohash and Abd El-Nasser 2010; Sathappan, Sivanesh, and Dhanasekaran 2019; Zewail et al. 2019). Reported that spraying of soya bean plants with yeast extract increased the chemical contents of soya bean plants especially NPK.

Yield and finger properties of banana

Banana yield and finger properties such as period from shooting to harvest, bunch weight, yield and hand weight of Grande Naine banana plants were positively responded to yeast extract-K fertilization in both seasons (Table 4). However, the shortest period from shooting to harvest (107 and 109 days), were recorded by T9-treated plants, followed by T8-treated plants which recorded (109 and 109 days), in the first and second seasons, respectively. On the reverse, the longest period from shooting to harvest was recorded by T1 and T2 treatments in the two seasons. The rest treatments occupied an intermediate position between the aforementioned treatments in both seasons. Moreover, bunch weight, yield and hand weight of were the investigated fruiting parameters for Grande Naine banana plants pertaining their response to the differential application treatments. It is quite evident as shown from tabulated data in Table 4 that, RD + Yeast Extract 2000 + K 1000 mg/l/plant surpassed statistically all other treatments during both 2017 & 2018

experimental growing seasons. However, RD + Yeast Extract 2000 + K 500 mg/l/plant and/or RD + Yeast Extract 1000+ K1000 mg/l/plant ranked statistically as the second after the superior one (T9). On the contrary, T1 was significantly the inferior, whereas the least value in this regard was observed during both seasons of study. In addition, the other investigated treatments were in between the aforesaid two extremes with a noticeable degree of efficiency linked with RD + Yeast Extract 1000 + K500 mg/l/plant for increasing the abovementioned parameters compared to the analogous members of such intermediate treatments during 2017 & 2018 experimental seasons.

The improved beneficial effects of K fertilization and yeast extract on flowering and early maturity were reported in earlier studies (Abou El-Yazied and Mady 2012; Helaly and El-Hoseiny (2017). They suggested that yeast extract as a natural biofertilizer and rich source of phytohormones particularly cytokinins, sugars, vitamins, enzymes, amino acids and minerals exerted stimulating effects on photosynthetic process and sugar metabolism to improve yield and finger properties of banana.

The impact of K and yeast extract on increasing banana yield attributed to their synergistic effects on metabolic functions and growth relative to the control (Table 4). The improved growth consequently translated into higher bunch and hand weights. Increasing growth and productivity of plants in response to either K fertilization or yeast extract amendments were reported in other studies. Helaly and El-Hoseiny (2017) indicated that the benefits effects of yeast as a natural biofertilizers on banana were due to balanced nutrition and functional regulations by vitamins and cytokinins.

Potassium condenses the activity of nicotinamide adenine dinucleotide phosphate oxidases and retains the photosynthetic electron transport activity, which supports to decrease Reactive oxygen species (ROS). Potassium insufficiencies reduce the photosynthetic carbon dioxide fixation, the transport and utilization of assimilates Waraich et al. (2012). In addition, Potassium regulates the biosynthesis, translocation, and allocation of metabolites that eventually increases the fruit yield and finger quality Islam and Muttaleb (2016).

Fruit quality of banana

Yeast amendments and K fertilization significantly improved fruit quality parameters (physical and chemical characteristics) over the control (Figures 1–3). However, (RD + Yeast extract 2000 + K 1000 mg/l/plant) and (RD + Yeast Extract 2000 + K 500 mg/l/plant) were statistically the superior in this concern during both 2017 and 2018 experimental growing seasons. However, the 7th treatment was (RD + Yeast Extract 1000+ K 1000 mg/l/plant) ranked statistically second, descending followed by (RD + Yeast Extract 1000 + K 500 mg/l/plant). On the contrary, the least values of the abovementioned parameters were usually in concomitant to Control or recommended doses (RD) which ranked statistically last values during both growing seasons of study. On the other side, all investigated nutritive fertilizer treatments resulted significantly in reducing total acidity and starch % as compared with control (Recommended doses). The most effective treatment for reducing total acidity and starch % was in closed relationship to Grande Naine banana plants subjected to the RD + Yeast Extract 2000 + K 1000 mg/l/plant (9th treatment) during both 2017 & 2018 experimental seasons. Whereas the highest reduction in total acidity and starch % was exhibited. On the contrary, RD + Yeast extract 1000/plant (2nd treatment.) was significantly the inferior, whereas the least reduction in total acidity and starch % below in control was observed during the two growing seasons of study.

Potassium is one of the important regulators element to catalyze respiration, photosynthesis, chlorophyll biosynthesis, and water regulation properties of the plants (Mengel and Kirkby 1987). It is reported that K is a perilous in water relations along with transportation and accumulation of sugars in the plant (Mengel 1997). With K optimization, banana plants increased its vigor, fruit weight, number of fingers per bunch, and weight and width of the middle fruit (Atim et al.

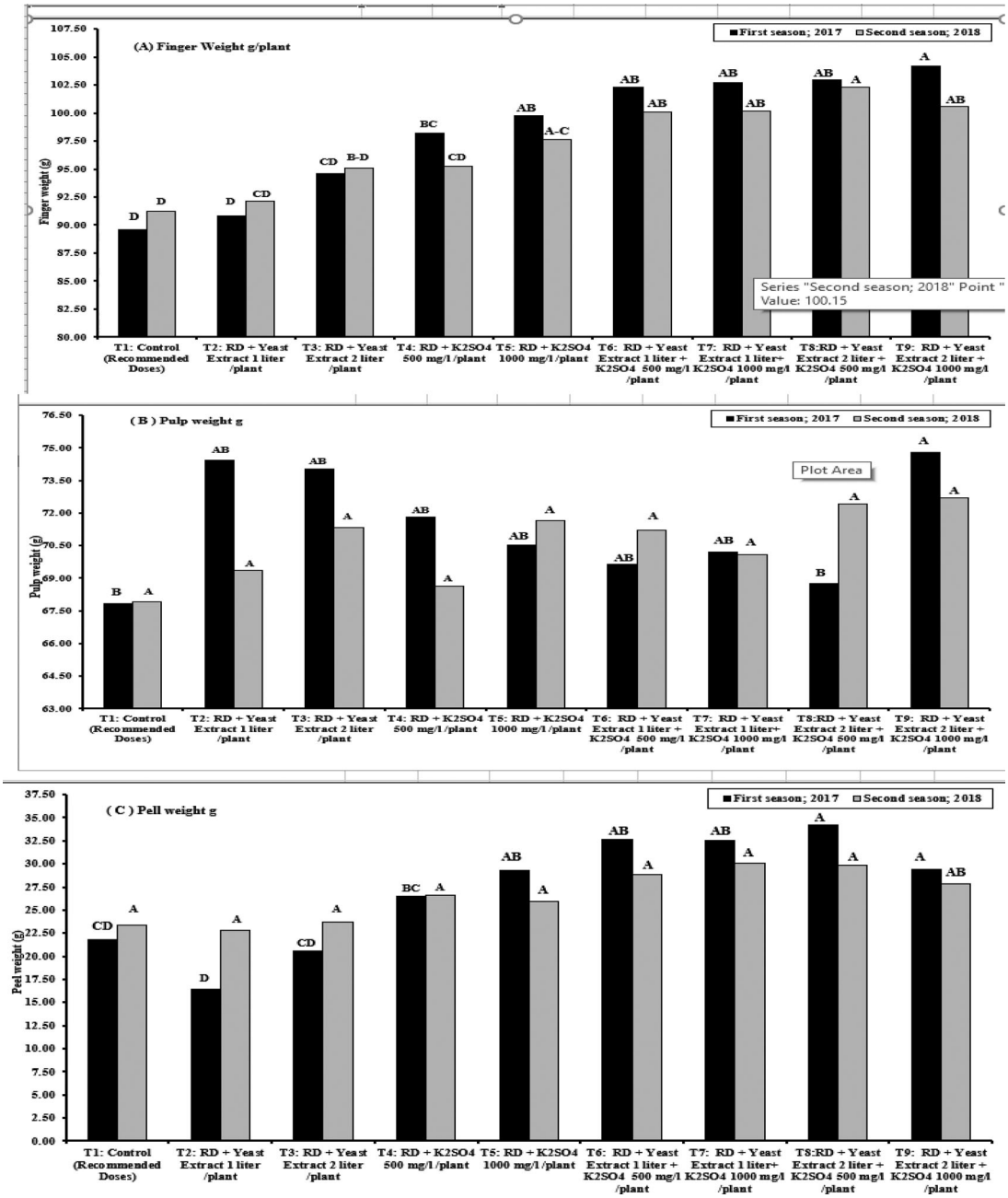

Figure 1. Effect of yeast extract and potassium on Finger weight, pulp weight, Peel weight (g) in banana plants during 2017 and 2018 seasons.

2013). In addition, K shortened time to fruit maturity and improved the storage superiority of bananas. The beneficiary effects of K on fruit quality was reported on plants by Al-Wasfy (2013).

The nutritional and bio-stimulant effects of yeast extract influenced the bio-assimilation of pigments and carbohydrates associated with progressing improvement in finger quality (Soliman et al. 2000). Our results agreed with those reported by El-Shazly and Mustafa (2013) and El-Boray et al. (2015), who reported that active yeast helped to develop TSS and vitamin C content of the fruits. Abd El Hamid (2014) indicated that a beneficial role of yeast extract as a bio-

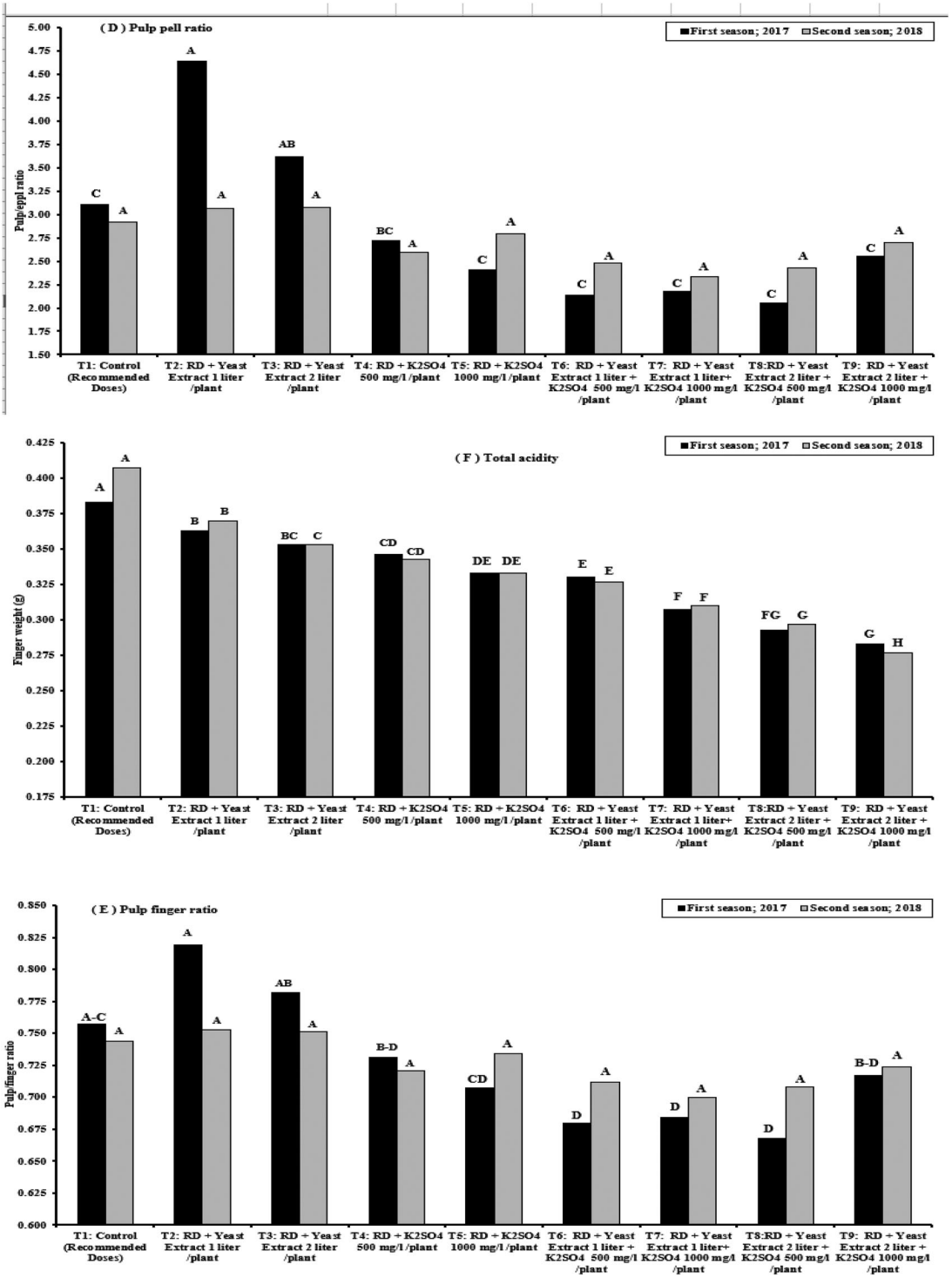

Figure 2. Effect of yeast extract and potassium on pulp pell ratio, total acidity, pulp finger ratio (g) in banana plants during 2017 and 2018 seasons.

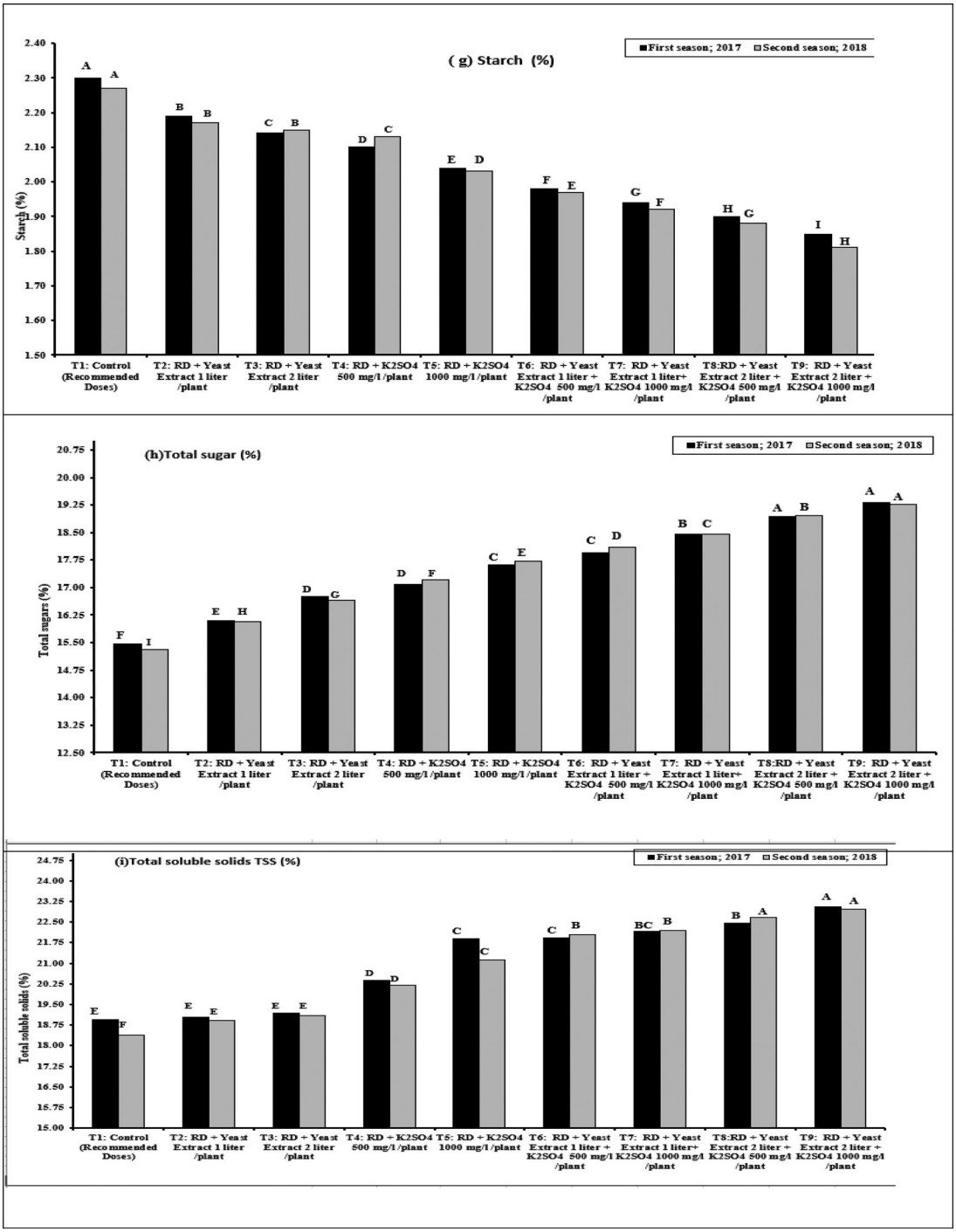

Figure 3. Effect of yeast extract and potassium on starch percentage Total sugar percentage and Total soluble solids TSS percentage in banana plants during 2017 and 2018 seasons.

stimulant to increase total and non-reducing sugars in fruits. Likewise, Helaly and El-Hoseiny (2017) reported that while integrated K and yeast extract significantly increased TSS, vitamin C and total sugar contents, but decreased fruit pulp/peel content and total acidity of banana fruits.

It is reported that using natural compounds are important sources of bio-growth regulators to improve establishment, growth and yield of plants under arid and semi-arid climatic conditions (Mahmood et al. 2010; Ahmed-Samah 2011). Though, the mode of action of bio-stimulants such as yeast extract is not very defined but its function as a source of phytohormones and plant signaling particles are responsible for efficient uptake of water and mineral nutrients followed by transportation and circulation of photosynthates (Calvo, Nelson, and Klooper 2014). Moreover, yeast extract is very a relatively safe product for human, animals and environment to help plant's establishment with improvements in water- and nutrient efficiency under arid and semi-arid conditions.

Conclusion

From this study it can be recommended that integration of balanced K fertilization with yeast extract will improve metabolic functions, growth, yield and quality of banana. spraying of Grande Naine banana plants with K_2SO_4 at 500 mg/l with yeast extract at 2000 ml per plant as drench soil application besides the recommended doses on monthly basis six times during the period from October to March under arid and semi-arid conditions these treatments could provide the best results for most of the growth, productivity and fruit quality parameters, as well.

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