INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 17, No. 3, p. 10-15, 2020

RESEARCH PAPER OPEN ACCESS

Comparative study of foliar application of various beer products and sakkara brewing on plant growth, flowering and fruit setting of Cucumber *(Cucumis sativus)* plants

Shyamalee Kohombange*[1], R. G. A. S. Rajapaksha[1], Nandun Rathnasekara[2], H. G. Gunathilaka[1], M. M. S. P. Munasingha[1]

[1]*Horticultural Crops Research and Development Institute, Gannoruwa, Sri Lanka*

[2]*Epsilon Crest Research, Ward Place, Colombo, Sri Lanka*

Article published on September 18, 2020

Key words: Beer, Cucumber, flowering, Fruit setting, SBr.

Abstract

Cucumber (*Cucumis sativus*) is an important vegetable crop in the tropics. Beer brewing is an intricate process encompassing mixing and further elaboration of four essential raw materials. “Sakkara”, Sri Lankan name for jiggery made by sugar cane stem extract. Sakkara Brewing (SBr) is also an intricate process like beer. It has reported that foliar application of beer and SBr resulted in significant growth stimulation in plants. The objectives of the present study were to compare the effects of five commercially available beer products and SBr on growth, flowering and fruit setting of cucumber plants. The study was conducted at farmer’s poly tunnel in a Completely Randomize Design with seven treatments randomized in five replicates. The treatments were T1 – Carlsberg Special Brew (8.8% Ethanol), T2 – Carlsberg (4.8% Ethanol), T3 – Lion Strong (8.8% Ethanol), T4 – Lion Stout (8.8% Ethanol), T5- Lion Larger (4.8% Ethanol), T6 – SBr (2.2% ethanol, 4% methanol, 2.4 x 10^4 yeast cells per $1mm^3$ and PH= 3.36) and T7 – Control (without spraying). Plants were established in pots and standard crop management practices were done. Products were sprayed to the seedlings 15 days after sowing and continued 6 times at 10 days intervals. Measurements were taken on growth, flowering and Fruit setting stages. The higher values of plant growth, reproductive and yield parameters were observed in beer and SBr applied treatments compared to control. SBr is very low cost product compared to commercially available beer. So, it can be recommended for vegetable cultivation as economically feasible and eco-friendly organic product.

* **Corresponding Author:** Shyamalee Kohombange ✉ shyamaleekohombange@gmail.com

Introduction

Beer is a fermented aqueous drink based on starch and flavored by hops. Beer brewing is an intricate process encompassing mixing and further elaboration of four essential raw materials, including barley malt, brewing water, hops and yeast. Beer is a complex mixture; over 400 different compounds have been characterized in beer which, in addition, contains macro molecules such as proteins, nucleic acids, carbohydrates and lipids. Some of the constituents of beer are derived from the raw materials and survive the brewing process unchanged. Others are the result of chemical and biochemical transformation of the raw materials during malting, mashing, boiling, fermentation and conditioning. Together all these constituents make up the character of beer but, in general, different beers and lagers contain different proportions of the same compounds rather than novel constituents. Beer constituents can be divided into volatile and nonvolatile components (Hough *et al.,* 1982).

Ethanol has been shown to have effects in plant tissues, often associated with ethylene activity (Heins, 1980; Saltveit, 1989; Wu *et al*., 1990; Mencarelli and Hugo, 1991) and on stomatal resistance by its effect in removing leaf resin (Meinzer *et al.,* 1990). Young tomato plants were treated with foliar sprays of methanol and ethanol. Concentrations ranged from 5 to 20% v/v. foliar sprays resulted in significant growth stimulation. Both alcohols increased leaf and stem fresh and dry weights with the maximum increases at the highest concentrations tested (Rowe *et al.,* 1994). Advanced flowering and fruit setting, number of flowers per plant, number of female flowers per plant and number of fruits per plant were recorded from beer (ethanol 8.8%) applied treatments. So, beer applied plants showed superior results in contrast to control with enhancing flowering as well as fruit setting performances in bitter gourd (Shyamalee *et al.,* 2019).

Sakkara brewing (SBr) is a fermented aqueous drink based on cane sugar and yeast (*Saccharomyces cerevisiae)*. SBr is an intricate process encompassing mixing and further elaboration of essential raw materials, including cane sugar, water and yeast. It contains around $5x10^8$ yeast cells per $1mm^3$, 0.5% ethanol, 3% methanol and P^H of the SBr is 4.29. The highest values of plant growth parameters and reproductive parameters of Cucumber were observed in 20% SBr applied treatments (Shyamalee *et al.,* 2019). Also, the highest values of plant growth parameters and reproductive parameters of Ridge gourd were observed in 40% SBr applied treatments (Shyamalee *et al.,* 2019). Yeast as a natural source of cytokinins-stimulates cell division and enlargement as well as the synthesis and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Kraig and Haber, 1980; Spencer *et al.,* 1983; Casel franco and Beale, 1983 and Fathy and Farid, 1996). It is used as a kind of bio fertilizers in soil fertilization or in foliar application on the shoots of vegetable crops (El-Ghamring *et al.,* 1999). This is because it's content of many nutrient elements and being productive compounds of semi growth regulator compound like auxins, gibberellins and cytokinins (Glick, 1995). Moreover, Gomaa *et al.,* (2005) reported that inclusion the foliar application of yeast significantly increased potato yield in comparison with the positive control. Also, Hussain and Khalaf, (2007) found that spraying yeast solution treatments significantly increased plant height, number of branches/plant, dry matter of vegetative growth, number of tubers/plant, dry matter percentage of tubers, yield/plant, dry matter percentage of tuber, yield/plant and TSS. All the above mentioned characters were increased with increasing the foliar application of yeast treatments. Recently, Sarhan and Abdullah, (2010) mentioned that the treatments of yeast suspension caused gradual significant increase in plant height, number of aerial stem, leaves area, total chlorophyll and shoots dry matter percentage.

Beer spraying is a normal practice in some Sri Lankan farmers especially for lettuce, tomato, leeks, bitter gourd and pumpkin (Personal communication with extension officers). The experiment reported here was designed to compare the foliar application of various beer brewings and SBr on plant growth, flowering and fruit setting of cucumber *(cucumis sativus)* plants under greenhouse condition.

Materials and methods

The study was conducted in greenhouse condition at farmers poly tunnel (WU1- Wet Zone area in Central Province), Sri Lanka. Plants were established in pots and standard crop management practices were done throughout the study. Five commercially available Beer brewings and SBr (2.2% ethanol, 4% methanol, 2.4 x 10^4 yeast cells per $1mm^3$ and P^H = 3.36) were sprayed at one week intervals after transplanting of seedlings in pots. 6: 30: 30 fertilizer mixture was used as recommended fertilizers. The treatments of all brewings applied to the seedlings to cover whole aerial parts of the plant at one week intervals as an aqueous spray by using a hand sprayer.

Table 1. Description of following treatments.

Treatment	Description
T1	Carlsberg Special Brew (8.8% ethanol) – Brewed from water, malted barley, rice, hops and food additives (INS numbers:150C)
T2	Carlsberg (4.8% ethanol) – Brewed from water, malted barley, hops and food additives (INS numbers: 224)
T3	Lion Strong (8.8% ethanol) – Brewed from water, rice, malted barley, hops and food additives (INS numbers: 150C)
T4	Lion Stout (8.8% ethanol) – Brewed from water, malted barley, sucrose, roasted malt, hops and food additives (INS numbers:150C)
T5	Lion Lager (4.8% ethanol) – Brewed from water, malted barley, rice, hops and food additives (INS numbers: 150C,224)
T6	SBr (0.5% ethanol, 3% methanol, $5x10^8$ yeast cells per $1mm^3$)
T7	Control (without any brewing)

Experimental design and data collection

The experiment was laid out in a Completely Randomized Design (CRD) with seven treatments randomized in five replicates. Data were collected at one week intervals after first spraying. Measurements were taken on growth, flowering and fruit setting determining parameters. Also, the experiment was repeated in two times.

Data Analysis

The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS) 9.1. Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05. Correlation analysis was used to determine the strength of the relationships between measured parameters of cucumber.

Results and discussion

Table 2. Effect of commercially available beer products and SBr on plant growth parameters of Cucumber.

Treatment	Mean plant height (cm)	Mean number of leaves per plant
T1	309^a	524^a
T2	260^a	501^{ab}
T3	300^a	515^{ab}
T4	285^a	474^{ab}
T5	292^a	460^{ab}
T6	295^a	429^{ab}
T7	281^a	382^b

Note: Means followed by the same letter/s along the column are not significantly different at P=0.05.

Results numerated that, there was no significant difference between plant heights among all treatments. The highest number of leaves was recorded in T1 i.e. Carlsberg Special Brew and lowest number of leaves were recorded in T7 i.e. control treatment. All other treatments were not significantly different compared to T1.

Table 3. Effect of commercially available beer products and SBr on parameters of flowering stage of Cucumber.

Treatment	Mean number of flowers per plant	Mean number of female flowers	Total flowers to female flowers percentage
T1	237^{ab}	27.3^a	11.5^b
T2	276.3^a	32.7^a	11.8^b
T3	237.3^{ab}	27.3^a	11.5^b
T4	232.7^{ab}	34^a	14.5^a
T5	217.7^{ab}	29.7^a	13.6^a
T6	224^{ab}	24.7^a	11^b
T7	180.3^b	12.7^b	7.1^c

Note: Means followed by the same letter/s along the column are not significantly different at P=0.05.

The highest number of flowers was recorded in T2 i.e. Carlsberg Brew and lowest number of flowers was recorded in T7 i.e. control treatment. All other treatments were not significantly different compared to T2 i.e. Carlsberg. When considering the number of female flowers, lowest value was recorded in control and all other treatments were showed higher values and significantly difference with control treatment.

The highest percentage of total flowers to female flowers was recorded in T4 i.e. Lion Stout and lowest value was recorded in T7 i.e. control treatment. Other treatments were also in higher values compared to the control treatment. Results numerated that, Beer and SBr promoted the female flowers of Cucumber and it may caused to higher yield.

Table 4. Effect of commercially available beer products and SBr on plant yield parameters of Cucumber.

Treatment	Mean number of fruits per plant	Total yield (Kg)	Per fruit weight (g)
T1	8^{ab}	6.6^{a}	825^{a}
T2	9^{a}	3.3^{b}	366^{bc}
T3	7.3^{ab}	3.7^{b}	507^{b}
T4	9.7^{a}	4.7^{b}	485^{b}
T5	8.3^{ab}	4.1^{b}	494^{b}
T6	6.7^{ab}	4.9^{b}	731^{a}
T7	4.3^{b}	1.2^{c}	279^{c}

Note: Means followed by the same letter/s along the column are not significantly different at P=0.05.

The higher number of fruits was recorded in T2 i.e. Carlsberg Brew and T4 i.e. Lion Stout. But, there was no significant difference between T1 i.e. Carlsberg Special Brew, T3 i.e. Lion Strong, T5 i.e. Lion Lager and T6 i.e. SBr with T2 i.e. Carlsberg Brew and T4 i.e. Lion Stout. Also the lowest number of fruits was recorded in T7 i.e. control treatment. The highest yield per plant was recorded in T1 i.e. Carlsberg Special Brew and lowest yield per plant was recorded in T7 i.e. control treatment. Other treatments were also in higher values compared to the control treatment. T1 i.e. Carlsberg Special Brew and T6 i.e. SBr increase the per fruit weight as well as bigger fruits is produced thus the total yield increase due to its application compare to other beer brewings and control.

Nonomura and Benson (1992) proposed that the increase in growth caused by ethanol or methanol is the result of the inhibition of photorespiration. This hypothesis however needs to be tested further as other mechanisms may be involved. Whatever the mechanism, use of methanol and possibly ethanol, to increase growth and reproductive parameters may provide significant benefits are also reflected in yield, on a range of agriculturally important C3 crop plants. Likewise, El-Tohamy *et al.,* (2008) found that foliar application of yeast increasing cytokinins content especially at the high level of yeast (10g/l.). Yeast treatments had the best results concerning yield as well as N, P and K contents in the leaves. Cytokinin stimulates the metabolism and the formation of flowers on side shoots, and as such it is a counterpart to auxin.

The characteristic flavour and aroma of any beer is, in large part, determined by the yeast strain employed and the wort composition. In addition, properties such as flocculation, wort fermentation ability (including the uptake of wort sugars, amino acids, and peptides), ethanol and osmotic pressure tolerance together with oxygen requirements have a critical impact on fermentation performance. Yeast management between fermentations is also a critical brewing parameter (Graham, 2016).Volatile aroma compounds, in particular higher alcohols and esters, have a direct influence on beer quality. These compounds produced by yeasts during fermentation impart characteristic fruit and floral flavours to beer, and different aroma profiles can define particular beer styles and brands. The aromatic complexity of alcoholic beverages produced by spontaneous fermentation has been attributed to the presence of various yeast species, all of which may contribute to the final flavour profile. (Jolly, Varela and Pretorius 2014; P ´erez-Torrado *et al.,* 2017; Varela and Borneman, 2017). This may be due to the fact that yeast strains change the composition of the beer product and it affects to the growth and yield parameters of the plants in various ways.

Conclusion

Commercially available beer brewings and SBr showed remarkable and same kind of effects for cucumber plants in growth and reproductive parameters compared to control. This may be the reason that some Sri Lankan farmers practice spraying of beer for their vegetable crops. Especially, SBr is very low cost product compared to commercially available beer brewings. So, SBr can be recommended and introduced for vegetable cultivation as economically feasible and eco-friendly organic product.

Acknowledgement

Ms. Anoma Senarathna, Deputy Director of Agriculture (Research), Food Research and Development Unit, Gannoruwa & A.D. Dishan C. Dharmasena, Attorney- at- law, No: 762, Romiyel Mawatha, Panagoda, Homagama.

References

Castelfranco PA, Beale SI. 1983. Chlorophyll biosynthesis: recent advances and areas of current interest. Annual Review of Plant Physiology **34(1),** 241-276.

El-Ghamriny EA, Arisha HME and Nour KA. 1999. Studies on tomato flowering, fruit set, yield and quality in summer season. 1.-spraying with Thiamine, ascorbic acid and yeast. Zagazig Journal of Agricultural Research **26(5),** 1345-1364.

El-Tohamy WA, El-Abagy HM, El-Greadly NHM. 2008. Studies on the effect of putrescine, yeast and vitamin C on growth, yield and physiological responses of eggplant (*Solanum melongena* L.) under sandy soil conditions. Australian Journal of Basic and Applied Sciences **2(2),** 296-300.

Fathy SL, Farid S. 1996. Effect of some chemical treatments, yeast preparation and royal Jelly on some vegetable crops growing in late summer season to induce their ability towards better thermal tolerance. Journal of Agricultural Sciences **25(4),** 2215-2249.

Glick BR. 1995. The enhancement of plant growth by free-living bacteria. Canadian Journal of Microbiology **41(2),** 109-117.

Gomaa AM, Moawad SS, Ebadah IMA, Salim HA. 2005. Application of bioorganic farming and its influence on certain pests infestation, growth and productivity of potato plants. Journal of Applied Sciences Research **1(2),** 205-211.

Graham GS. 2016. Saccharomyces species in the Production of Beer. The International Centre for Brewing and Distilling, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, Scotland, UK; Profggstewart@aol.comAcademic

Heins RD. 1980. Inhibition of ethylene synthesis and senescence in carnation by ethanol. Journal of the American Society for Horticultural Science **105(1),** 141-144.

Hough JS, Briggs DE, Stevens R, Young TW. 1982. Chemical and Physical Properties of Beer. Malting and Brewing Science.

Hussain W, Khalaf L. 2007. Effect of foliar spraying with yeast solution on growth and yield of potato plant cv. desiree. html/www.tropentage. de/2007/abstracts/links/khalaf. FPRAXY 90.

Jolly NP, Varela C, Pretorius IS. 2014. Not your ordinary yeast: non-Saccharomyces yeasts in wine production uncovered. FEMS Yeast Res **14,** 215-37.

Kriag E and Haber JE. 1980. Messenger ribonucleic acid and protein metabolism during sporulation of *Saccharomyces cerevisiae*. Journal of Bacteriology **144(3),** 1098-1112.

Meinzer FC, Wisdom CS, Gonzalez-Coloma A, Rundel PW, Shultz LM. 1990. Effects of leaf resin on stomatal behaviour and gas exchange of Larrea tridentata (DC.) Cov. Functional Ecology **4(4),** 579-584.

Mencarelli F, Hugo L. 1991. Control of flower and bract abscission of Bougainvillea branches by ethanol solutions. Agricoltura Mediterranea **121,** 282-286.

Nonomura AM, Benson AA. 1992. The path of carbon in photosynthesis: improved crop yields with methanol. Proceedings of the National Academy of Sciences, USA **89(20),** 9794-9798.

P´erez-Torrado R, Barrio E, Querol A. 2017. Alternative yeasts for wine-making:Saccharomyces non-cerevisiae and its hybrids. Crit Rev Food Sci Nutr 2017, DOI: 10.1080/10408398.2017.1285751

Rowe RN, Farr DJ, Richards BAJ. 1994. Effects of foliar and root applications of methanol or ethanol on the growth of tomato plants (*Lycopersicon esculentum* Mill). New Zealand Journal of Crop and Horticultural Science **22(3),** 335-337.

Saltveit ME. 1989. Effect of alcohols and their interaction with ethylene on the ripening of epidermal pericarp discs of tomato fruit. Plant Physiology **90(1),** 167-174.

Sarhan T, Abdullah OK. 2010. Effect of Azotobacter Inoculation, Dry Bread Yeast Suspension and Varying Levels of Urea on Growth of Potato Cv. Desiree. html/www.tropentage.de/2010/abstracts

Shyamalee Kohombange, Rajapaksha RG, Nandun Rathnasekara AS. 2019. Effects of Foliar Application of Beer (Ethanol) on the Growth, Flowering and Fruit Setting of Bittergourd (*Momordica charantia* L.) Plants. International Journal of Research **6(1),** 501-v505.

Shyamalee Kohombange, Rajapaksha RG, Nandun Rathnasekara AS. 2019. Effects of Foliar Application of "Sakkara" Brewing on the Growth, Flowering and Fruit Setting of Cucumber *(Cucumis sativus*) Plants under Greenhouse Condition, International Journal of Current Innovations in Advanced Research, Volume 2, Issue 4, April 39-43, ISSN: 2636-6282.

Shyamalee Kohombange, Rajapaksha RG, Nandun Rathnasekara AS. 2019. Effects of Foliar Application of "Sakkara" Brewing on the Growth, Flowering and Fruit Setting of Ridge gourd *(Luffa acutangula)*) Plants under Greenhouse Condition, International Journal of Current Innovations in Advanced Research, Volume 2, Issue 3, March 23-28, ISSN: 2636-6282.

Spencer TFT, Dorothy SM, Smith ARW. 1983. Yeast genetics fundamental and applied aspects. Springer-Verlag, New York, USA 16-18pp.

Varela C, Borneman AR. 2017. Yeasts found in vineyards and wineries. Yeast **34,** 111-28.

Wu MJ, Zacarias L, Saltveit M, Reid MS. 1990. Effect of alcohols on Carnation senescence. Proceedings of the XXIII International Horticultural Congress, Firenz.e 2*:* Abstract 3402.