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EXTRACTION AND UTILIZATION OF BANANA PSEUDOSTEM SAP AS ORGANIC LIQUID BIO-FERTILIZER ON ONION (*ALLIUM CEPA* L)

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ABSTRACT

The high input cost of onion production through the application of chemical fertilizers is a significant concern for small farmers. Every year, Banana harvesting generates a large amount of banana pseudostem waste, which is generally burnt or thrown away despite containing many nutrients after harvest. Utilizing the banana's pseudo-stem sap as liquid fertilizer for increasing onion productivity through sustainable agricultural practices, a greenhouse trial was conducted to determine the optimum banana pseudo-stem sap (BPS) to be applied by foliar spray. There were five treatments designed in CRD with four replicates. The reduced mineral fertilizer was given to test the impact of the pseudostem sap on the seedlings. The results indicated that sap application showed a positive and significant effect on all parameters of onion seedlings. The onion plant height increased to 48.96 cm, the number of leaves was 14.50, and the shoot length of 8.67 cm was recorded best. The onion bulb diameter ranged from 3 to 6 cm bulb weight from 54 to 92.75 g comparing the control. The best rate found was 80% RDF, along with 20% BSP in all parameters. It can be concluded that application of 80% RDF + Foliar spray of 20% BPS was found to be the most viable option for getting higher growth and yield in onion. This will reduce 20% chemical fertilizer and about 25% increase in the yield. This will be an eco-friendly practice and sustainable ergonomically, economically and environmentally.

Key words: BPS, Onion seedlings, liquid organic fertilizer, climate change

INTRODUCTION

Onion is one of the major vegetable crops and economical source of small farmers in Sindh. It is very nutritious and to be used as daily use in cooking every diet. Onion is rich in vitamins carbohydrates and the best source of potassium. The onion is grown in major districts like Badin Matyari, TandoAlahyar. Sindh contributes about 44.42 % in the country's total onion production, followed by Baluchistan (27.27%), Punjab (18.97%) and KPK (9.35%) (GoP, 2020). However, the average productivity of onion is still very low in comparison to other other provinces. There are several factors for low onion yields. Onions are very sensitive to scarcity of nutrients than most vegetables; hence they mostly respond well to added fertilizers (Asodariya *et al.*, 2022). Continuous use of these soil applied chemical fertilizers depletes essential soil nutrients and minerals that are naturally found in fertile soil. Therefore, substitution of chemical fertilizers by the low cost organic liquid fertilizer through foliar application is very important for sustainable onion and vegetable production

(Sulanke *et al.*, 2013; Islam *et al.*, 2023). On the other hand, banana is the most important fruit crop widely grown around 93% in Sindh (Abro *et al.*, 2016). Generally, after harvesting banana crop leaves huge biomass as pseudostems, leaves, trashes amounting almost 35 lac tons every year and farmers due to unawareness burnt this waste in Sindh (Sharma *et al.*, 2017; Abro *et al.*, 2019). While extracting the fiber from pseudostem that obtained (BPS) sap about 5000-6000 liter/acres⁻¹. Banana sap as liquid fertilizer contains high concentration of potassium (Dangaria *et al.*, 2016; Mehta *et al.*, 2023). Although banana plant especially in pseudostem contains 80–85% fluid Islam *et al.*, 2012) and to be considered an effective organic fertilizer (Faozi *et al.*, 2018) due to higher concentration of NO₃-N, NH₄-N, K, P, Ca, Mg, Zn, and Fe in it (Cao *et al.*, 2018). The BPS based liquid organic fertilizer is rich in both macro and micronutrients and is able to auto-synthesize plant growth regulating substances like cytokinin and gibberellic acid during its preparation (Modi *et al.*

2021; Patil *et al.* 2017). It contains a lot of phytochemicals depending on the genotypic variation, age, and plant parts it is situated in (Deng *et al.*, 2020). Recycling of banana waste as compost and liquid bio-fertilizer or offers best solution to the disposal crop waste and improved soil health (Dauda *et al.*, 2013). Research studies have shown that the banana corm or hump extract increased the N, P, and K uptake of onion, linseed Asodayia *et al.*, 2022; Kotadiya et a. 2023) and initiated the growth and yield of mango (Modi *et al.*, 2021). The amendment of banana waste organic fertilizer increased the plant height, leaf size, and yield of soyabean (Aini *et al.*, 2019) due abundance of inherent mineral nutrients. To best of our knowledge there is little literature published especially in our area on the use of banana pseudostem sap extraction and its use on the growth attributes and yield of onion. The present research work was therefore designed with the following objectives a) extract and laboratory analysis of BPS for EC, pH & NPK b) foliar application of BPS with different concentrations on growth and yield attributes of onion..

MATERIALS AND METHODS

Experimental site & trail: The experiments were conducted department of Soil Science Sindh Agriculture University Tandojam Tandojam (2°48'16.1" N, 101°30'10.99" E), Hyderabad Sindh 31st July 2021 during the dry season.

Collection and preparation of BPS: Mature and non-productive banana pseudostems were collected

from a banana field. The banana pseudostems were immediately washed with fresh tap water after removing the rotted or infected sheath to clean the dirty surface.

Raspador machine: The pseudostems were unfolded and then washed twice with distilled water, then chopped into two halves and the sap was collected via raspador banana fiber extractor operation (Agri Equip Pvt Ltd). About 1.5 L BPS was collected and retained in a clean airtight glass jar. Half of the collected sap was immediately preserved in a refrigerator at -16 °C for phytochemicals analysis, while the other half was preserved at 4 °C to determine the chemical properties.

BPS analysis: The pH was measured from BPS samples utilizing a digital pH meter (HI 2211 pH meter, Hanna Instruments, Woonsocket, Rhode Island, USA), whereas the electrical conductivity (EC) in the same samples was determined by digital EC meter (Hanna 2300). The total N was determined by TruMac CNS analyzer (Leco, St. Joseph, Missouri, USA). The collected BPS was diluted 50 times with distilled water in order to determine the properties of total nutrients, namely P, K, Ca, Mg, Na, Zn, Cu, and B through inductively coupled plasma (ICP)- optical emission spectroscopy (Optima 8300, PerkinElmer Corporation, Norwalk, Connecticut, USA) with the standard solutions. The chemical properties of BPS samples are described more detail in Table 1

Table 1. Chemical properties of BPS.

Parameters	Results
EC (ds m ⁻¹)	0.61
pH	7.8
N (%)	0.8
P (mg kg ⁻¹)	1.45
K (mg kg ⁻¹)	150
Zn (%)	43.5
GA (%)	44
CA (%)	12.5
Means ± standard deviations, average of 3 replicates	

Soil Analysis: The soil related analysis includes physico-chemical properties of onion field's i.e particle size distribution by Hydrometer method (Bouyoucos, 1962). pH and EC in 1:5 soil-water extract (McLean, 1983). organic matter by Walkley-Black method (Walkley & Black, 1934). Total N by Kjeldahl's method (Jackson, 1962). AB-DTPA extracting solution was used for extracting P and K, from soil (Soltanpour and Schwab, 1977) and the extracts was analyzed for and P using spectrophotometer (Cattenie, 1980) and K on flame photometer (Knudsen *et al.*, 1983).

Experimental design and Treatments: The experiment includes five treatments with four replications and the experiment was laid in complete randomized design (CRD). The treatments were T1=

Control, T2=0.5% BPS+100% RDF T3=1.0% BPS+90% RDF, T4=2.0% BPS+80% RDF, T5=3% BPS+70% RDF, with four replicates and 20 **total pots**

Growth & yield parameters: Plant height (cm) was measured from base of plant to the tip of the longest leaf with measuring scale. The numbers of leaves per plant were counted manually. In each treatment, the observations were recorded in replicates of four. Length of shoot (cm) was measured from lower part of plant to the tip of the longest leaf with measuring scale. Bulb diameters were measured with digital vernier caliper for five randomly selected bulbs from each treatment.. Bulb weight was measured for five randomly selected bulbs from each treatment using a weighing machine.

Statistical analysis and interpretation: The data will be used for analysis of variance by Statistics Ver. 8.1 Software (Statistix, 2005). The means of the

data was compared using Least Significant Difference test <0.005.

Table 2 Basic soil properties before conducting experiment.

Parameters	Results
Organic Matter (%)	0.91
EC (ds m ⁻¹)	0.61
pH	7.8
N (%)	0.8
P (mg kg ⁻¹)	1.45
K (mg kg ⁻¹)	150
Sand (%)	43.5
Silt (%)	44
Clay (%)	12.5
Texture	Loam

RESULTS AND DISCUSSION

The results indicated that experimental soil was loam in soil texture, non-saline (0.61 dSm⁻¹) slightly alkaline in reaction (7.8), adequate in organic matter content (0.91%). The soil was low in N (0.8 %), low in AB-DTPA extractable P (1.45 mg kg⁻¹) and adequate in extractable K (150 mg kg⁻¹). With respect to the importance of onion production worldwide, providing suitable conditions for the optimum yield production is of great significance. In order to enhance the productivity of onion, there is need to generate appropriate technologies with respect to inorganic fertilizer management along with organics like BPS under micro-irrigation system (drip). While separating fibers from the banana pseudo stem, the liquid available is known as BPS which contains sufficient amount of essential macro and micro plant nutrients. The BPS based liquid organic fertilizer is rich in both macro and micronutrients and is able to auto-synthesize plant growth regulating substances like cytokinin and gibberellic acid during its preparation (Modi *et al.* 2021; Patil *et al.* 2017).

Growth attributes

Plant height and shoot length(cm): Banana pseudostem sap and chemical fertilizer application

had a substantial impact on plant height of onion as shown in fig 1. The data of plant height revealed that T₄ (2.0% BPS+80% RDF) had the tallest plant height (48.90 cm) than control (32.37 cm). Furthermore, the use of Banana pseudostem sap and chemical fertilizer increased plant height. this increase in plant height may be the result of increased meristematic activity caused by improved cell division and cell elongation due to increased auxin levels in the tissue or conversion of tryptophan to Indole Acetic Acid (IAA) by enriched pseudostem (Desai *et al.*, 2020). The shoot length of onion plant was greatly influenced due to the addition of banana pseudostem sap and chemical fertilizer application (Table 4.5). It was noticed that the sole application of NPK and prepared banana pseudostem sap enhanced the shoot length of onion plants, but the effects were more prominent under integrated supplementation of chemical and banana pseudostem sap. The data of length of shoot revealed that T₄ (2.0% BPS+80% RDF) had the maximum length of shoot (8.67 cm) than the control (3.00 cm). These results correlate with Misal *et al.*, (2015), the application of two sprays of banana pseudostem enriched sap (2%) increased the plant height and length of shoot. The results are in agreement with (Mehta *et al.*, 2023).

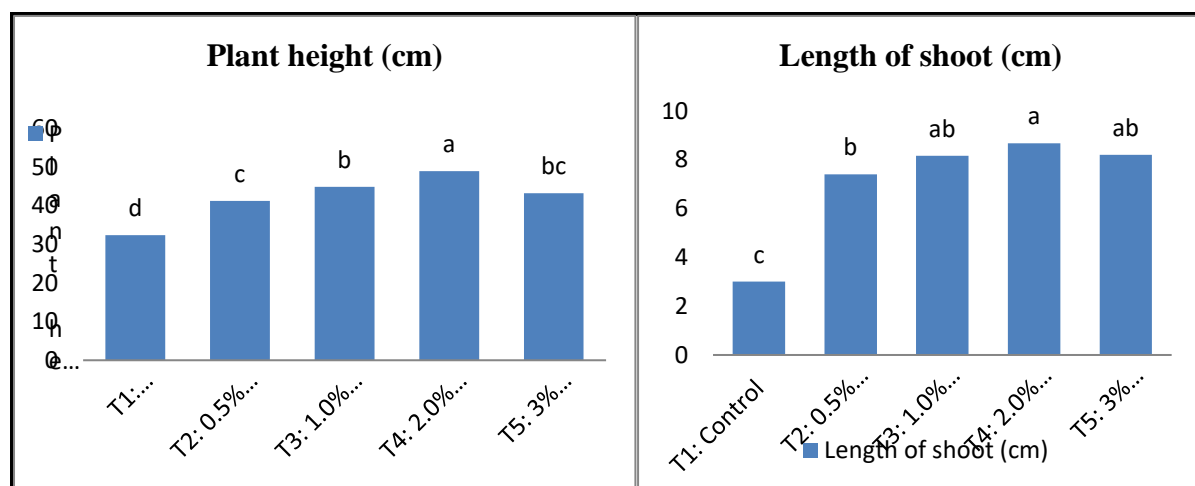


Fig No 1 Effect of banana pseudostem sap and chemical fertilizer application on plant height of onion

Number of leaves: Banana pseudostem sap and chemical fertilizer application had a substantial impact on number of leaves of onion as shown in Fig 2. The number of leaves per plant ranged from 10.50 (T₁ & T₅) to 14.50. Consideration of all treatments where maximum number of leaves per plant (14.50) were found in T₄ (2.0% BPS+80% RDF) and minimum number of leaves per plant (10.50) was in T₁ control. The enriched BPS significantly improved the SPAD value of corn at all growth stages might be due to the abundance of macro and micronutrients (N, P, K, Ca, Mg, and Zn) in the foliar application of enriched sap (T₃) and their faster absorption helped

increase the chlorophyll synthesis significantly. The results are in complete agreement with the findings of the (Modi *et al.*, 2019; Islam *et al.*, 2023). The presence of macro and micronutrients, as well as growth regulators, in the pseudo stem sap may explain the increase in the number of flower buds per shoot. As a result, the plants remain physiologically more active to build up sufficient food stock for growing flowers by producing a favorable C:N ratio in the terminals, resulting in an increased number of flower buds per stem Christian *et al.* (2022)

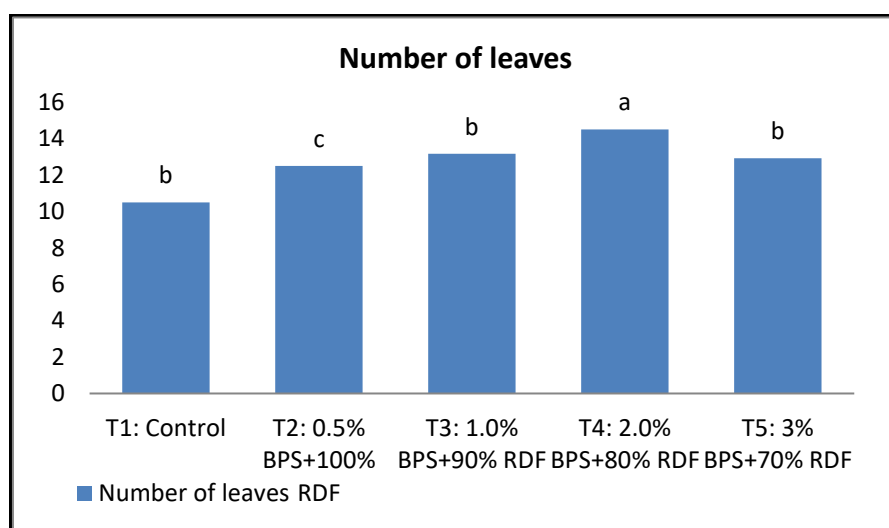


Fig No 2 Effect of banana pseudostem sap and chemical fertilizer application on number of leaves of onion

Yield attributes

Bulb diameter (cm) Bulb weight (g): The bulb diameter was significantly affected by banana pseudostem sap and chemical fertilizer application had a substantial impact on bulb diameter of onion as shown in (Fig 3). The bulb diameter ranged from 4.22 cm (T₁) to 6.0 cm (T₄). Banana pseudostem sap 2%, 3% and chemical fertilizer with RDF 80% and 70% produced greater bulb diameter than the T₂ 0.5% BPS+100% RDF and T₃ 1.0% BPS+90% RDF. Increase in bulb growth was attributed to the better utilization of photosynthates and increased allocation of photosynthates towards the economically useful parts. These findings are in conformity with the results of Vekaria *et al.* (2018) and Asodariya *et al.*, (2022) in onion. The bulb weight was significantly affected by banana pseudostem sap and chemical fertilizer application had a substantial impact on bulb weight of onion as shown in (Fig 3).). The bulb diameter ranged from 54.25 g (T₁) to 92.75 g (T₄). Banana pseudostem sap 2%, 3% and chemical fertilizer with RDF 80% and 70% produced greater bulb diameter than the T₂ 0.5% BPS+100% RDF and

T₃ 1.0% BPS+90% RDF. Higher production of such substrates of banana pseudostem impacts the production of large sized bulbs and higher marketable onions (Mohamed *et al.*, 2018).

Banana Pseudostem Sap contains macro and micronutrients, as well as growth promoting compounds that induce plant overall growth, the total yield may be attribute-able to the larger production of dry matter, resulting in increased weight and diameter of flowers, resulting in higher yield per plant Kalariya *et al.* (2018), This result is consistent with the findings of Parmar *et al.* (2020). This might be due to higher carbohydrate buildup in the plant during the early stages of growth, resulting in improved nutritional delivery, which causes an increase in fruit size and, as a result, an increase in average fruit weight in terms of length and diameter. Bud and flower diameters were found to be significantly affected by 2 % BPS in roses Singh *et al.* (2022).

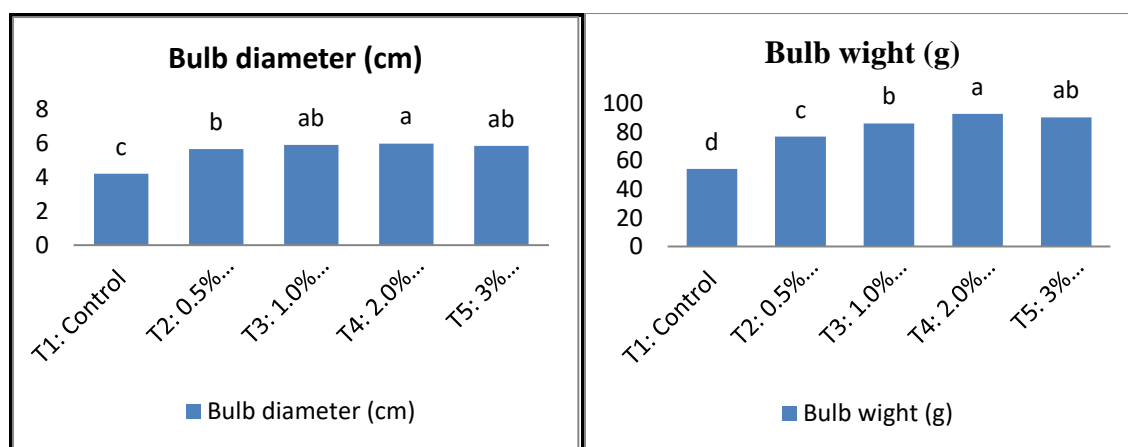


Fig No. 3 Effect of banana pseudostem sap and chemical fertilizer application on bulb diameter & bulb weight of onion

CONCLUSION

From the results of the present investigation it can be revealed that the application of enriched BPS as foliar spray with 20% recommended dose of soil-applied fertilizer increased vegetative growth and yield attributes. The combined effects of soil-applied fertilizers with enriched BPS also soil sustainability in terms of availability of major plant

nutrients and onion yield can be achieved with application of 80% RDF + 2% foliar spray of BPS for higher in onion bulb yield and number of leaves. Thus, foliar-sprayed BPS can be utilized as a supplementary nutrient source or organic liquid fertilizer but it is recommended that more validation filed conditions are require.

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