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Impact of Various Priming Agents on the Performance of Sugarcane (*Saccharum officinarum*) through Chip Buds

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ABSTRACT

Sugarcane is one of the valuable crops in Pakistan. It contributes much to the GDP of Pakistan. But the production technology to produce sugarcane is very old in Pakistan. The new and more efficient method of sugarcane sowing is the bud chips sowing method, also known as Sustainable Sugarcane Initiative (SSI) method. Two varieties of sugarcane, CPF-246 and CP-77/400, were grown by the buds chips method, and seedlings were treated by the following treatments 0.4% Isabion solution, 2% SOP solution and 1:30 MLE solution, respectively, in both varieties. Seedlings treated with 2% SOP solution have the best germination and gained maximum height as compared to 0.4% Isabion and 1:30 MLE solution. We concluded that farmers could get better germination and growth of sugarcane crops by using the bud chips method and treating their seedlings with a 2% SOP solution.

Keywords: *Cane yield, chip bud sugarcane, row spacing, seedlings treatment, SOP, MLE, Isabion.*

INTRODUCTION

Sugarcane refers to several species of the Saccharum genus in the Poaceae family. *Saccharum officinarum*, *S. Barberi*, *S. robustum*, *S. sinense*, and *S. spontaneum* are the most well-known. Sugarcane species have a wide range of chromosomal numbers, ranging from 48 to well over 150. Sugarcane (*Saccharum officinarum*) was probably first planted in New Guinea. Borneo, Burma, Java, Malaya, and the Philippines were all used to get to India. It migrated from there to Arabia, China, and Persia (Nazir, 1994).

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After conquering India, Alexander the Great brought this honey reed to Africa. It reached Europe in the fourteenth century via Egypt and Morocco and then travelled to the Caribbean and Brazil in the seventeenth century (Reddy, 2004). Sugarcane cannot withstand cold temperatures and will stop growing if the temperature falls below 120 degrees Celsius. At a temperature of around 34 ℃, the maximum photosynthetic rate occurs (Reddy, 2004). Sugarcane is a valuable industrial and cash crop in Pakistan and many other countries. It is grown in tropical and sub-tropical climes around the world, in conditions ranging from hot and dry near sea level to cold and damp at higher elevations. Aside from sugar, sugarcane produces a variety of valuable byproducts such as alcohol, which is used in the pharmaceutical industry, ethanol, which is used as a fuel; bagasse, which is used in the paper and chipboard industries; and press mud, which is a rich source of organic matter and nutrients for crop production. Pakistan is a big name in the world's cane-producing countries. It is ranked fifth in cane acreage and production and nearly 15th in sugar production. This, according to shards of evidence, began in Indo-Pak. Its description can be found in 1000 B.C. Indian mythological literature. Sugar, sugarcane, and other sugar-producing methods were unknown to ancient peoples. Sugar, on the other hand, was marketed in Chinese markets in the mid-eighteenth century. Sugar was exclusively found on the tables of aristocrats and the wealthy in European countries.

Growth is a complicated process of living organisms that manifests itself as growth in weight, size, and the formation of new organs. During the crop's life cycle, the general trend in growth is sigmoid (S-shaped), which is typical of all growth. The growth of a sugarcane plant can be divided into three distinct phases: (1) the formative phase, which lasts from germination to maximum tillering; in spring-planted sugarcane, this phase lasts until the end of June; (2) grand growth phase, which begins with the arrival of monsoon and lasts until the beginning of winters. Sugarcane elongates during this phase and accumulates the most dry matter; (3) maturity phase; sugar is stored in the stalk during this phase (Yadava, 1991).

The percentage of seeds that germinate directly impacts plant population per unit area, making it an important crop production component. Germination refers to the activation and sprouting of undamaged buds and the commencement of root development on a portion of stalk used as a planting material in sugarcane. Previous studies found that nitrogen (Alexander et al., 2002; Jeyaraman and Alagudurai, 2003; Patel et al., 2004) or NPK (Ali et al., 2002; Afzal et al., 2003; Mishra et al., 2004; Sinha et al., 2005; Usmanikhail et al., 2007) application, as well as time of application (Alexander et al., 2002; Mishra et al., 2004). The number of shoots per unit area, which is an essential statistic, has a direct impact on sugarcane crop yield. Many previous studies found a significant difference in the number of tillers per plant/hectare when nitrogen levels were varied from 0, 50, 100, 150, and 200 kg ha-1 (Bokhtiar et al., 2002) and 275, 325, and 375 kg ha-1 (Jeyaraman & Alagudurai, 2003) while increasing nitrogen levels did not affect the number of tillers per hectare (Alexander et al., 2002; Patel et al., 2004). Increases in nitrogen up to 150 kg ha-1 (Yadav & Sharma, 1980), 200 kg ha-1 (Sharma & Gupta, 1991), and 225 kg ha-1 (Sharma & Gupta, 1991) increased dry matter (DM) accumulation (Lal, 1991). The highest sugarcane DM yield (38.1 t ha-1) was achieved using 250-110-110 kg NPK ha-1, while the lowest DM yield (25.0 t ha-1) was achieved using 250 kg N ha-1 alone (Ingawale et al., 1992).

MATERIALS AND METHODS

The research was conducted in the Punjab province's Multan district in North Pakistan. Multan district, Multan division's divisional headquarters, is located at 30.1575° north latitude, 71.5249° east longitude, and 403 feet above sea level. It is located on the Chenab River's bank. On the north and northeast of Multan district Khanewal is located, with

Vehari district on the east and Lodhran district on the south. The district's average annual rainfall is 175 mm. The district, on the other hand, has ensured irrigation facilities thanks to abundant subterranean water resources. The city's average annual temperature is 25.6°C. In the current project, two cultivars of sugarcane were used. Names of these cultivars are CP 77/400, CPF 246. CP 77/400 is a leading variety in Khyber Pakhtunkhwa, whereas; CPF 246 is a high-yielding variety of Punjab province.

CP 77/400: Percentage: CP 65/315 x CP 71/400. It is a popular sugarcane cultivar in Pakistan's Khyber Pakhtunkhwa province. It's the product of a cross that was built in Louisiana and then transported to Canal Point. This cultivar was first introduced in 1996. Pakistan Agriculture Research Council got the variety, which was then delivered to the Sugar Crops Research Institute in Mardan. The variety was tested in a number of selection experiments at the institute and found to perform better than other mid-maturing types. It did well in farmer's fields as well, and the white and crystalized gur, the lovely cane, has since been recognized. Among other recognized kinds, it covers the majority of the growing area in Khyber Pakhtunkhwa. The variety is frost resistant and matures in the middle of the season. CP 77/400 is a cultivar that is in the middle of maturing. It produces 85-90 tons of cane per hectare. CCS (commercially recoverable sucrose) has a percentage of 12.30 per cent. It is a desirable type that both researchers and farmers have suggested. Cane is medium thick, tall, semi-erect, and medium hard, with a whitish tint. There are no splits or ivory markings on the internodes, which are longer and cylindrical. The buds are oval, medium in size, and hairless. It has drooping, medium-broad leaves with a smooth surface. There is no pubescence on the leaf sheath. Trashing is unrestricted at this age.

CPF-246: Parentage: US 90-1093 x CP 81-1425. It is a Punjab cultivated cane variety with a medium maturing, high yielding, good ratooning, and erect cane. It was put through preliminary, semi-final, medium, and late final varietal trials in Pakistan for four years (2006-2010). It is cultivable in all Punjab. It is a higher cane yielder variety with 100-135 t/ha than commercial varieties with a cane yield of 100, 100 and 95 t/ha than SPF- 245, SPF-234 and HSF-240, respectively. These are cultivated in over 75 per cent of the sugarcane area in Punjab. It is a medium-maturing variety and maintains good recovery throughout the crushing season. Despite the fact that this strain grows to a great height, it does not lodge. Because of its erectness and sturdy stand nature, it has the potential to preserve yield and recovery. The majority of the tillers produced mature into canes that can be milled. This type does not produce offshoots or sprouts during the growing season, allowing it to reach greater heights while using fewer resources and maintaining its quality. It is resistant to a wide range of insects and illnesses. It can also withstand being submerged in water.

Three types of chemicals were applied as seed treatments for sugarcane bud chips in this study, which were applied at the seedling stage. Isabion, Potash, and MLE were the three seed treatments. All of these were administered in three stages as a foliar spray.

Isabion is a product of Syngenta (a multinational agrochemical firm) for balanced plant nutrition that can be applied both foliar and through irrigation water. It's made up of a mix of free amino acids and short and long peptide chains, and it encourages root growth and aggressive bud development, increases blooming, stimulates pollination and fruit set, and boosts harvest quantity and quality. Isabion is the outcome of a technique that transforms natural collagen into a product that meets the highest manufacturing and quality criteria. Isabion is available as a liquid on the market. In recent experiments, Isabion was used as a foliar spray on sugarcane seedlings in solution form. The goal was to see if sugarcane growth differed in response to Isabion foliar spray. To achieve a 0.4 per cent Isabion solution, 4 ml of Isabion was mixed with enough water to make a total of 1L solution. The sugarcane seedlings were then sprayed with this solution in three 333.33ml

splits as foliar spray. All of these splits were sprayed at a four-day interval.

Potash fertilizer is sometimes known as "potash," a word derived from an early industrial method in which potassium was extracted from wood ashes and concentrated by evaporating the leachate in enormous iron pots ("pot-ash"). Clearly, this technique is no longer viable and is unsustainable in the long run. Potash (about 95 per cent) is largely used in fertilizers to promote plant growth, increase agricultural output and disease resistance, and conserve water. In plant tissue, potassium is linked to the flow of water, minerals, and carbohydrates. It influences protein, starch, and adenosine triphosphate (ATP) production by activating enzymes within the plant. The creation of ATP can control the rate of photosynthesis. The solid dry powdered form of potassium is most commonly utilized. Potash is usually applied in the form of SOP (potash sulphate) or MOP (potash phosphate) (muriate of Potash). SOP was used as a potash supply in this project. SOP is most commonly used as a dry powder. However, in recent research, SOP was administered to sugarcane seedlings as a foliar spray in liquid form. The goal was to see if sugarcane growth differed in response to foliar potash spray. To achieve a 2 per cent SOP solution, 20gm of SOP was mixed with enough water to generate a total 1L solution. The sugarcane seedlings were then sprayed with this solution in three 333.33ml splits as foliar spray.

MLE: The solid dry powdered form of potassium is most commonly utilized. Potash is usually applied in the form of SOP (potash sulphate) or MOP (potash phosphate) (muriate of Potash). SOP was used as a potash supply in this project. SOP is most commonly used as a dry powder. However, in recent research, SOP was administered to sugarcane seedlings as a foliar spray in liquid form. The goal was to see if sugarcane growth differed in response to foliar potash spray. To achieve a 2 per cent SOP solution, 20gm of SOP was mixed with enough water to generate a total 1L solution. The sugarcane seedlings were then sprayed with this solution in three 333.33ml splits as foliar spray. MLE was utilized as a foliar spray on sugarcane seedlings because of its favourable characteristics. In order to see how it affects sugarcane development and growth. To produce a 1:30 ratio, 33.33ml of concentrated MLE was combined in enough water to make a 1L solution. The sugarcane seedlings were then sprayed with this solution in three 333.33ml splits as foliar spray. All of these splits were sprayed at a four-day interval.

Coco-pith: (formed when coconut husks are processed for the extraction of the long fibres from the husk). Coco peat is a great growing medium for indoor and outdoor plants. It is also one of the best seed germination media commonly used with potted plants. It enhances soil aeration for healthy root growth while maintaining optimal plant nutrient availability. Perlite is an amorphous volcanic glass with a high water content that is often created when obsidian is hydrated. It is found in nature and can remarkably expand when heated rapidly. Perlite is typically used to aerate the compost. However, it can also assist in retaining some water. It's ideal for free-draining potting compost for plants like cacti and succulents requiring good drainage. It can also aid in the creation of airy seedling compost. Peat moss is a natural substance created by layers of moss growing on top of each other. (The lowest layer is made up of peat moss.) Peat moss is sterile, with an acidic pH and a low concentration of nutrients and microbes. Most potting soils and seed-starting media contain peat moss as a key ingredient. It can store its weight in water several times and release it to the plant roots as needed. It also holds onto nutrients, preventing them from being washed out of the soil when the plant is watered.

Peat moss + Perlite: Perlite was added to peat moss for enhanced bud chip germination in this sugarcane bud chip experiment. Because bud chips are more delicate than setts placed directly into the soil, they should be used with caution. Perlite and peat moss are used to promote healthy plant growth. Because perlite is so light, it won't weigh down your plants, allowing your seedlings to sprout and thrive without hindrance. Peat moss, unlike other organic compounds like manure compost, is devoid of

nutrients. It's also devoid of any beneficial bacteria. As a result, you can use peat moss to amend the soil and other materials, but you can't expect the plants to develop strong and properly if you use it alone. Therefore perlite was used in it.

Seedling trays: You can manage the environment in which seeds grow by growing them in paper pots, modules, or seedling trays. It protects the garden from the elements and pests and controls soil, moisture, fertility, and heat. This is especially crucial if you want to get a head start on the growing season.

Layout: The layout of this experiment was RCBD. There were 4 rows and 6 columns. The complete layout of the experiment is shown in Table 1.

Table 1: Showing the experiment layout.

	R^1		R^2		R^3	
	CPF 246	**CP 77/400**	**CPF 246**	**CP 77/400**	**CPF 246**	**CP 77/400**
T^0	Control	Control	Control	Control	Control	Control
T^1	0.4% Isabion	0.4% Isabion	0.4% Isabion	0.4% Isabion	0.4% Isabion	0.4% Isabion
T^2	2% Potash	2% Potash	2% Potash	2% Potash	2% Potash	2% Potash
T^3	1/30 MLE	1/30 MLE	1/30 MLE	1/30 MLE	1/30 MLE	1/30 MLE

RESULTS AND DISCUSSIONS

We discovered that employing this current sugarcane-growing technology is more efficient and cost-effective. In which a farmer/grower can produce high sugarcane yields at a low cost of production. By utilizing the bud chips growing approach, we only needed 5000 single-budded chips as seed, which is far less than the traditional sugarcane growing method, which required 16,000 three-budded setts (48,000 buds). As a result, this method uses around ten times less seeds than the traditional method. The biggest portion of the cost of production in the conventional technique was spent on seeds, which is decreased to around 75% in this sustainable method. Bud chips are grown in seedling trays first, where they have a better chance of germinating properly, as bud chips are too sensitive to grow in the field directly. Another advantage of this system is that we can grade our sugarcane plants at the seedling stage to ensure plant consistency. Nursery is the only reason this is feasible. Because we used this strategy to build a nursery, we had to move the seedlings into the field eventually. Direct planting was used in the traditional approach. This new sugarcane cultivation approach also differs in planting arrangement since it maintains a 5-foot space between rows of sugarcane, which is much broader than the traditional method, which employed a row spacing of 1.5-2.5 feet between rows. Plants have more access to air and sunshine with this wider spacing than with the traditional method.

Table 2: Showing mean heights of the treatments used in the experiment.

	CPF 246	**CP 77/400**
Control	14.433 C	12.467 D
0.4% Isabion	14.700 C	16.033 BC
2% Potash	18.333 A	19.100 A
1/30 MLE	17.900 AB	18.167 A

Table 3: Showing the days of germination of different treatments used in the experiments

	CPF 246	**CP 77/400**
Control	12.00 D	11.3 CD
0.4% Isabion	10.33 BCD	9.33 ABC
2% Potash	8.000 AB	7.33 A
1/30 MLE	9.000 ABC	8.33 AB

Furthermore, irrigation water is used significantly less in this sustainable sugarcane farming process than in traditional methods. We used to flood the entire field with water in the traditional approach, but with this method, we only need a small amount of water because of the furrow irrigation system, which can retain moisture with less water. Drip irrigation is also viable because of the large spacing of 5 feet, which can save 90 per cent of water. In conventional sugarcane farming, the number of tillers each sett ranges between 10 and 15, which is half as many as in sustainable sugarcane cultivation, which estimates 25 to 30 tillers per chip. In this bud chips method, the loss of plants is also reduced as the mortality rate is much less than in the conventional method of sugarcane cultivation. So, using the bud chips approach, we can get 9-10 mill-able sugarcanes. Using the traditional approach, we only obtain 4-5 mill-able canes per plant. We are allowed to intercrop between the rows of sugarcane in the sustainable sugarcane production method, which is another benefit of the wide spacing used in this method. Cowpea, chickpea, potato, green gram, watermelon, wheat, and a variety of other crops can be grown. We can benefit more from these additional crops in this way.

In 7 to 14 days, the germination process was completed. Seedlings treated with Potash had the best germination results. In just 6 to 8 days, these have completed their germination. Seedlings that had been treated with MLE germinated in 7 to 9 days. Isabion-treated seedlings germinated in 8 to 11 days after sowing, while control seedlings took 10 to 13 days to emerge. On the basis of types, the CP 77/400 variety from Khyber Pakhtunkhwa showed earlier germination than the Punjab-sown CPF 246 variety. When the heights of seedlings were compared after 35 days of seeding, when they were ready to be transplanted in the field, the seedlings treated with foliar Potash spray performed the best. Seedlings fed with a foliar spray of Potash grew to a maximum height of 17 to 20 inches. Seedlings treated with MLE foliar spray reached heights of 16 to 19 inches. Seedlings sprayed by Isabion reached heights ranging from 13 to 17 inches. Whereas; seedlings with no treatment just got a height of 11 inches to 15 inches. On comparison of heights of the varieties, the CP 77/400 variety from Khyber Pakhtunkhwa showed higher heights than the CPF 246 variety sown in Punjab.

We conclude that if a farmer uses the sugarcane bud chips approach, he will be able to produce at least 20% more sugarcane while using 30% less water and 25% less chemicals. There is currently no proven approach to do both — reduce water pressure while increasing productivity. Also, they should use the foliar application of Potash as seedlings treatments for better results. In addition, farmers will be able to grow another short-term crop in between the rows to generate additional income using this strategy. Sugarcane millers will be able to use both their machinery and their human resources.

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All authors contributed equally, and equal response is observed from all authors

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