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Original Research Article

IMPACT OF SEED PRIMING IN BOOSTING COTTON GERMINATION AND YIELD IN WARM AREAS

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Abstract *Cotton (Gossypium hirsutum L) has a high-ranked and exceptional position in the farming system of the globe. It is mainly grown during the kharif season. High temperature is one of the restricting and consistently approaching dangers to cotton efficiency in Pakistan. It has given a big loss in the recent few years. The plant parts like seedlings, bolls, and fiber quality attributes are incredibly affected because of high temperature. Production of cotton is decreasing due to many reasons mainly pest infestation and high temperatures. To fill the yield gap, an experiment was conducted in which different concentrations of plant extracts i.e. Sugar Beet Root Extract (1%), Watermelon Juice (1%), Moringa Leaf Extract (1%), Jantar Leaf Extract (1%), Spanish Leaf Extract (2%), Carrot Root Extract (1%), Ginger Root Extract (1%), and Lemon Juice (1%) were used. All growth-promoting substances had a significant impact on crop growth and yield attributes. However, maximum yield was associated with priming of seeds with moringa leaf extract (3%). Germination percentage (86.5), number of bolls plant-1(54.7), yield (3.5 tons ha-1), biological yield (11.8 tons ha-1), and harvest index (31.5) were significantly boosted by moringa leaf juice as priming agent. Based on the experiment, different parameters on the growth and yield of cotton were examined and analyzed statistically by using the least significant digit (LSD) at 5% through standard procedures.*

Keywords*:* *cotton*; *Gossypium hirsutum; leaf extract; ginger; moringa*

Introduction

Ginger (*Zingier officinale Roscoe)* is a valuable Cotton has a high-ranking and exceptional position in the farming system of the agricultural world. It is also famous as a "WHITE GOLD" in cotton-making developed countries (Tarazi et al., 2019). Pakistan is ranked in the fifth largest production of cotton in the world. Textile materials, products, and the export of cotton have around 60 % of shares in the overall trades of Pakistan. It adds about 0.6 % to the gross domestic product and 2.4 % of the worth added to the agricultural system. In the past 10 years or so, the cotton areas have been replaced with other crops like sugarcane, maize, potato, and rice which give more profit and less fear of losses., the cropped area under cotton dropped to 1.9 million hectares (6.8 percent) against last year's 2.0 million hectares during 2021-22. Cotton production has increased to 8.329 million bales (17.9 percent) in comparison to last year's 7.064 million bales with 731 kg ha-1 yield. Despite the decrease in cropped regions, production and yield of cotton expanded because of very developed and improved varieties. (Government of Pakistan, 2021-22). Cotton, the Gossypium class in the family Malvaceae, in the clan Gossypiae, was divided into twice parts: wild & developed cotton. Out of the 50 known species, only four are developed (Gotmare et al., 2004). The four normally developed cotton species are *G. herbaceum, G. hirsutum, G. arboreum,* and *G. barbadense* (Liu et al., 2013).

In Pakistan, Cotton is developed for the most part in Punjab and Sindh areas. Punjab is responsible for a large portion of the production of cotton, delivering 79 % of all cotton in Pakistan (Naheed and Rasul, 2010). In Pakistan from May until June when the temperature is typically extremely high, the cotton cultivating season starts and afterward collecting

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starts in September and goes on until December. In Pakistan, wide utilization of pesticides is normal, and with pests turning out to be more resistant to pesticides, assessed losses in the production of cotton vary from ten to fifteen percent in a customary year to 30 to 40% in a terrible cultivating year (Salam, 2008). Plant extracts are eco-friendly, defensive, curative, and battle against illness. Plant growth regulators have long been used to help plants' growth and development. It is also used to improve abiotic and biotic stress tolerance which resulting higher economic returns (Mohamed and Gomaa, 2012). Natural antioxidants from food plants, such as spices and herbs, are increasingly being researched for their safety and effectiveness. Seedling growth is improved by Moringa, which strengthens the plant, increases the biomass (stems and leaves) by 20% to 35%, increases the lifetime of the plant by inducing resistance to disease and pests, and finally increases the yield of the plant by 20% to 35% (Abbas et al., 2024ab; Arshad et al., 2024; Chatta et al., 2024; Junaid and Gokce; Fuglie, 2001).

The timing of flower development and pollination, boll, plant growth & fruit formation, as well as cotton output, depends on extreme temperature swings and strong rains, particularly in late July and early September. Negatively impacted as a result of the plants' extreme stress during these times (Ali et al., 2019). The main obstacle to Pakistani cotton production is insects. The high cotton productivity in Pakistan is significantly hampered by suckers (including whiteflies, jassids, and aphids) and bollworms (such as the American bollworm, spotted bollworm, and pink bollworm). Untimely rains and extreme heat can sometimes make farmers disinterested in pest control, causing crop damage and significant productivity reductions (Malik et al., 2015). Very effective and long-established method of enhancing the seed quality is "priming." As a result of priming seeds, it has been found that crop output and resilience to biotic and abiotic stress have both risen. All of these characteristics that increase the competitiveness of a product are directly tied to seed vigor, a complicated agronomic characteristic that is influenced by numerous genetic and environmental factors (Haroon et al., 2024; Irfan et al., 2024; Sami et al., 2024; Rajjou et al., 2012)

Germination of seed is a challenging process including different metabolic occasions which bring about differences from put away food hold to initiation stage where radicle and plumule arise (Kamithi et al., 2016). Seed priming using plant extracts and chemicals has been utilized as a significant growth improvement strategy in crop plants (Yasmeen et al., 2013a). Plant development might restrained or stimulated by allele-synthetic compounds, for example, flavonoids, terpenoids, phenolic compounds, steroids, alkaloids, and saponins (Narwal, 1994). *Moringa oleifera* just got that much attention due to its special nutrients, carotenoids, flavonoids, amino acids, phenolics, and ascorbic acids like antioxidants and having zeatin and cytokinin in its leaves (Yasmeen, 2012). The extract of the leaves of moringa is applied to many various crops which significantly enhances the germination percentage of the seed, growth, and ultimately productivity under both normal conditions and stress-like conditions (Yasmeen et al., 2013b). The biomass of the okra plant was increased by the foliar application of the extract of sugar beet root, which ultimately increased the yield (Habib et al., 2012). Abbas et al., (2010) reviewed that in eggplant and tomato, the growth and yield are increased by the foliar application of the extract of sugar beet root in the form of Glycine betaine in salt-stressed plants. Ginger is a very useful herb used in Malaysia and all over the world, it contains various types of active minerals which improve human health and work as a very good antioxidant. This herb is used as a food additive in every kitchen. In plants, carotenoids are forerunners of vitamin A, play significant jobs in the get-together of photograph frameworks, in light gathering, and photograph security, and as cancer prevention agents in safeguarding cells from the harming impacts of free revolutionaries (Chrubasik et al., 2005).

Carrot (Daucu scarota L.) roots contain anthocyanin, amino acids, proline, sugar, carotenoids, flavones, proteins, and filaments, showed that utilizing carrot juice builds the fresh weight, sun dry weight, and dampness content of the explants with expanding centralization of carrot juice in the medium (Puchooa and Ramburn, 2004). Lemon has stronger Vitamin E, limonene, citral, citrus extract alpha pinine, myrcene, and many more. The lemons cooperate with protein and astringent and have cell upward movement. Citrus natural balms showed a wide range of natural uses chiefly antimicrobial, cancer prevention agents, and cytotoxic uses (Karthik and Periyasamy, 2019). It contains caffeine as well as triterpene saponins, carotenoids, and non-protein amino acids (theanine, 2-amino-6-ethylamidoadipinic corrosive). Lemon juice has antifungal and antibacterial attributes that are powerful in controlling plant illnesses (Eddy et al., 2018). Jantar is a very much sensible yield. Soil productivity could be worked by the utilization of normal matter and green fertilizer or manure. Recently examinations of green fertilizer or manure as Nitrogen focal points for cotton may long time to be appropriate, since reproducers have evolved in cotton yield by growing it early (Lewis and Hunter, 1940). Spinach is a decent source of violaxanthin and neoxanthin because these sorts of mixtures are not financially accessible as supplements. Spinach (Spinaci aoleracea L.) is perhaps one of the very important critical antioxidative leaves, which contain

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around 1 gram of outright flavonoids per kg of spinach leaves. The possible flavonoid-like blends present in spinach were first revealed in 1943 (Weatherby and Cheng, 1943).

Watermelon (Citrullus lanatus) is an organic product that contains phytochemicals that are helpful to human health (Choudhary et al., 2015). Watermelon is a decent source of nutrients like vitamins B, C, and E as well as nutrients like iron, calcium, magnesium, and phosphorus.

Methodology

To concentrate on the effect of different psychological strategies to minimize the impact of heat stress on cotton and also increase the growth and stand establishment of cotton was performed at the agronomy research farm of the University of Agriculture Faisalabad sub campus Burewala throughout the late spring season of 2022. Without saline and sandy topsoil, a rich soil field was chosen for this experiment. This experiment was led to decide the effectiveness of different primed seeds on the growth of cotton under heat wave stress.

Priming Protocol for Field

100g of cotton seeds were primed in each case by soaking them for 15 hours at room temperature in each solutions Hydro priming (HP), Water Melon Juice (WMJ) (5%), Moringa leaf extract (MLE) (3%), Spanish Leaf Extract (SLE) (4%), Jantar leaf extract (JLE) (2%), Lemon Juice (LJ) (2%), Carrot Root Extract (CRE) (3%), Ginger root extract (GRE) (1%), and Sugar beet root extract (SBRE) (2%). An aquarium pump will be used for an adequate supply of oxygen to prime solution. Seeds will be dried under the shade for 24 hours to lose the excess moisture content after cleaning it with distilled water. The seed-to-mixture ratio was kept at 1:5.

Sowing

The net plot size was 3m by 3m, and the rows were placed 30 cm apart. Hoeing was carried out manually. To guarantee the best weed control in the crop 15- 30 days after sowing. After when weeds controlled by herbicides

Field Evaluation

Field experiments were conducted in the UAF Sub Campus Burewala Agronomic Research Field. For the field experiment, a simple Randomized Complete Block Design was used and data was analyzed by analysis of variance and means were compared by LSD test at 5%.

Results

Germination percentage

The number of plants that emerged in the field was calculated daily then the average figure was noted. Data showed that certain extracts exhibited a significant impact on germination percentage. According to data maximum germination (77.4 %) percentage was observed in 3% moringa leaf extract application followed by 1% ginger extract (75.6 %) while the lowest germination percentage (69.33) was observed in control. Data is given Table 1

T_{50} (Time Taken to 50 % Germination) (Days)

Daily observations of germination were made, and 50% germination was calculated following the Association of Official Seed Analysts' (1990) protocol on seedling evaluation. The formulas used by (Coolbear *et al.*, 1984) were used to calculate the time count till seedling emergence at fifty percent.

$$T_{50} = ti+[\{ (N/2) - n_j\} \div (n_i - n_j)] * (t_i - t_j)$$

Where N is used for the number of days for final germination count and n_i, n_j cumulative seeds number emerged at contiguous with days t_i, and t_j when $n_i < (N+1)/2 < n_j$.

Data showed that certain extracts exhibited a significant impact on the time taken to 50 % germination. According to data lowest time taken to 50 % germination (7.1 days) was observed in 3% moringa leaf extract application followed by 1% ginger extract (7.1 days) while the highest time taken to 50 % germination (9.8 days) observed in control. Data is given Table 1

Mean Emergence Time (MET) (Days)

The mean time for germination was taken according to the equation described by Ellis and Roberts (1981)

$$MGT= (\Sigma Dn \div \Sigma n)$$

Where, N Used for the number of seeds that appeared on day D, and D is the number of days counted from the start of the emergence.

Data showed that certain extracts exhibited a significant impact on mean emergence time. According to data lowest mean emergence time (7.0) days was observed in 3% moringa leaf extract application followed by 1% ginger extract (7.7) days while the highest mean emergence time (9.9) days was observed in control. Data is given Table 1

No. of leaves/plant

Three plants were randomly chosen from each plot to count the number of leaves on each plant and to calculate the average number of leaves. Data showed that certain extracts exhibited a significant impact on no. of leaves/plant. According to data maximum no. of leaves/plant (210) was observed in 3% moringa leaf extract application followed by 1% ginger extract (193) while the lowest no. of leaves/plant (123) was observed in control. Data is given Table 1

No. of Branches (Sympodial)

Three plants were randomly chosen from each plot, their branches counted, and then their average was calculated. Data showed that certain extracts exhibited a significant impact on no. of branches (sympodial). According to data maximum no. of branches (sympodial) (45.9) was observed in 3% moringa leaf extract application followed by 1% ginger extract (42.3) while the lowest no. of branches

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(sympodial) (24.3) was observed in control. Data is given Table 1

Plant Height (PH) (cm)

From each plot three plants were randomly chosen their length was measured with measuring tape from the soil surface of the final growth point and then the average was calculated. Data showed that certain extracts exhibited a significant impact on the plant height of cotton. According to data maximum plant height of cotton (48) cm was observed in 3% moringa leaf extract application followed by 1% ginger extract (44) cm while the lowest plant height of cotton (23) cm observed in the control Data is given Table 1

No. bolls/plant

Three plants were randomly chosen from each plot, their bolls were counted, and then their average was calculated. Data showed that certain extracts exhibited a significant impact on the number of bolls per plant. According to data maximum number of bolls per plant (54.7) was observed in 3% moringa leaf extract application followed by 1% ginger extract (51.6) while the lowest number of bolls per cotton plant (24.8) was observed in control. Data is given Table 1

No. Of Days from Emergence to Flowering (DEF) (days)

Data showed that certain extracts exhibited a significant impact on no. of days from emergence to flowering (days). According to data maximum no. of days from emergence to flowering (210) days was observed in 3% moringa leaf extract application followed by 1% ginger extract (193) days while no. of days from emergence to flowering (123) days observed in control. Data is given Table 2.

No. of days taken to physiological maturity (DPH) (days)

Data showed that certain extracts exhibited a significant impact on no. of days taken to physiological maturity (days). According to data lowest no. of days taken to physiological maturity (50) days was observed in 3% moringa leaf extract application followed by 1% ginger extract (54) days while the highest no. of days taken to physiological maturity (70) days observed in control. Data is given Table 2

LAI (Leaf Area Index)

Data showed that certain extracts exhibited a significant impact on the leaf area index. According to the data maximum leaf area index (4.24) was observed in 3% moringa leaf extract application followed by 1% ginger extract (3.93) while leaf area index (3.00) was observed in the control. Data is given Table 2

Yield (t ha^{-1})

An area of lm^2 will be taken from each experimental plot. Bolls with cotton seed will be collected to determine the cotton yield. Data showed that certain extracts exhibited a significant impact on seed cotton yield. According to data maximum seed cotton yield (3.5 t/ha) was observed in 3% moringa leaf extract application followed by 1% ginger extract (3.2 t/ha) while seed cotton yield (1.33 t/ha) was observed in control. Data is given Table 2

Biological yield (t ha^{-1})

An area of l m2 will be taken from each experimental plot. The weight of dry matter will be determined by weighing balance. Data showed that certain extracts exhibited a significant impact on biological yield. According to data maximum biological yield (11.9 t/ha) was observed in 3% moringa leaf extract application followed by 1% ginger extract (10.9 t/ha) while biological yield (5.8 t/ha) was observed in the control. Data is given Table 2

Harvest Index %

The Harvest index was computed by using the following formula given by Hunt (1979).

Harvest index = (Yield /Biological yield) x 100

Data showed that certain extracts exhibited a significant impact on harvest index %. According to data maximum harvest index (31.5 %) was observed in 3% moringa leaf extract application followed by 1% ginger extract (31.3 %) while the harvest index (23.2 %) was observed in the control. Data is given Table 2

Table 1: Effect of seed priming Treatments on given parameters of cotton

Treatments	Germination (%)	T50 (days)	MET (days)	No. of Leaves	No. of Branches	Plant Height(cm)	No. of Bolls/Plant
T1:Control	69.3	9.8	9.9	123.3	24.2	23	24.8
T2:DW	73.6	9.5	9.5	128.0	27.2	26	27.9
T3: SBRE	75.8	9.2	9.1	141.6	30.9	28	29.9
T4:WMJ	80.1	9.1	8.9	146.0	31.5	30	33.0
T5:MLE	86.5	7.1	7.0	210.0	45.9	48	54.7
T6:JLE	75.8	8.9	8.8	141.6	33.5	37	36.1
T7:SLE	80.4	9.1	8.4	150.0	36.8	33	39.2
T8:CRE	81.7	8.5	7.9	176.3	38.7	41	47.5
T9:GRE	85.2	7.9	7.7	193.3	42.3	44	51.6
T10:LJ	79.0	8.8	8.9	136.6	35.3	39	41.3

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LSD@5%	5.1	0.64	0.7	31.1	5.7	5.6	10.4

T_1: Control/Untreated, T_2: Distilled water, T_3: Sugar Beet Root Extract (1%), T_4: Watermelon Juice (1%), T_5: Moringa Leaf Extract (1%), T_6: Jantar Leaf Extract (1%), T_7: Spanish Leaf Extract (2%), T_8: Carrot Root Extract (1%), T_9: Ginger Root Extract (1%), T_{10}: Lemon Juice (1%)
MET: Mean Emergence time, T50: Time Taken 50% Germination

Table 2: Effect of seed priming Treatments on given parameters of cotton

Treatments	DEF (days)	DPH (days)	LAI	Yield (tha^{-1})	Biological Yield (tha^{-1})	Harvest Index (%)
T1:Control	52.4	82.3	3.00	1.3	5.8	23.2
T2:DW	50.6	78.6	3.15	1.6	6.0	27.1
T3: SBRE	49.9	71.0	3.30	1.8	8.2	21.8
T4:WMJ	47.6	72.0	3.41	2.2	7.6	29.4
T5:MLE	35.4	62.3	4.24	3.5	11.8	31.5
T6:JLE	43.4	76.0	3.36	2.1	7.6	29.0
T7:SLE	46.7	71.3	3.57	2.5	8.6	29.8
T8:CRE	39.0	69.0	3.83	3.2	10.7	29.3
T9:GRE	38.1	64.0	3.93	3.1	10.9	31.3
T10:LJ	40.6	72.3	3.67	2.8	9.6	29.6
LSD@5%	5.9	7.7	0.18	0.49	2.5	5.7

T_1: Control/Untreated, T_2: Distilled water, T_3: Sugar Beet Root Extract (1%), T_4: Watermelon Juice (1%), T_5: Moringa Leaf Extract (1%), T_6: Jantar Leaf Extract (1%), T_7: Spanish Leaf Extract (2%), T_8: Carrot Root Extract (1%), T_9: Ginger Root Extract (1%), T_{10}: Lemon Juice (1%), LAI: Leaves Area Index
DEF: No. Of Days from Emergence to Flowering, DPH: No. of days taken to physiological maturity

Discussion

The findings indicated that cotton crop seed cotton yield and characteristics were significantly impacted by the application of miracle plant leaf extract as seed priming or foliar spray. The present study demonstrates that seed soaking treatment effectively reduces cotton seed leachate electrolyte conductivity, demonstrating plasma membrane strength and stability (Panhwar, 2022). MLE's efficacy as a seed priming medium and foliar spray solution to boost cotton growth and yield was evaluated. Seed priming and foliar spray were hypothesized to be capable of overcoming the seed cotton yield, growth, and development constraints, thereby investigating the most adaptable method for the crops of cotton. It has been described to speed up wheat crop growth, increase yield, and improve resistance against diseases and pests. Its application method seed priming and foliar spray also has an impact on growth-enhancing properties. Seed priming has been shown in previous research to improve wheat crop yield as well as seed germination and seedling vigor. There is a positive effect on development and growth has been observed, when working with cotton crops, as has the use of foliar spray to combat the cotton leaf curl virus disease (Panhwar *et al.,* 2022). The findings indicated that cotton crop seed cotton yield and characteristics were significantly impacted by the application of miracle plant leaf extract as seed priming or foliar spray. The present study demonstrates that seed soaking treatment effectively reduces cotton seed leachate electrolyte conductivity, demonstrating plasma membrane strength and stability. (Panhwar *et al.,* 2022) The increment of plant height of cotton plants was due to primed seeds which served as a source of all essential nutrients, which are known to encourage plant growth. The number of bolls counted in plant 1 followed a similar pattern. The average number of bolls counted plant-1 was 65.2 from T4, while the lowest was 35.8 from control (T1) at 135 DAS. Additionally, CRIS-585 outperformed CRIS-342 in terms of plant height and boll-counted plant-1, but this difference was not statistically significant. According to (Foidl *et al.,* 2001) the presence of essential nutrients like ascorbic acid, zeatin, and others in MLE probably contributed to an increase in both the vegetative and reproductive growth rates.

The primary effect of MLE application was a significant correlation between an increase in MLE concentration and an increase in plant height (dry weight of the plant, no. of cotton plant fruiting branches per plant, root-to-stem ratio, relative water content, and leaf area) As MLE treatments, the data demonstrate that MLE foliar application positively affected yield and its components. In the principal season, showering cotton plants with MLE at a centralization of 30% delivered the best outcomes as far as number of opened bolls per plant, boll weight, seed record, and seed cotton yield (around 15.3, 15.27, 6.55, and 31.36 percent), while untreated cotton plants created the most minimal yield and its parts in the two seasons. The increment in yield and its components may be due to the effect of MLE application on growth, chemical constituents, and enzyme activity (Ibrahim *et al.,* 2021). The effectiveness of MLE natural growth enhancer and

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foliar application of potassium and nitrogen fertilizers in increasing cotton productivity and fiber quality is compared in this study. The application of potassium and MLE foliar spray to cotton crops had a significant influence on seed cotton yield, as this finding demonstrated. When applied at 3% MLE, 100 kg K2O ha-1, and 52.3 percent higher yields, respectively, it increased from 1721 to 2610 kg ha-1. Boll weight and seed index, which are related to yield, both increased, but neither was statistically significant. A high-yielding cotton crop of improved quality requires a high level of potassium nutrition. The miracle of foliar spraying of moringa leaves reduced the CLCuV plague and increased seed cotton yield (Panhwar *et al.*, 2022).

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Authors' Contribution

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