TRENDS IN ANIMAL AND PLANT SCIENCES
https://doi.org/10.62324/TAPS/2024.026
www.trendsaps.com; editor@trendsaps.com
E-ISSN: 3006-0559; P-ISSN: 3006-0540

RESEARCH ARTICLE

Effects of Osmopriming of Different Growth Regulators on Yield and Quality of Tobacco

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Article History: 24-24 Received: 13-Dec-2023 Revised: 15-Jan-2024 Accepted: 05-Feb-2024

ABSTRACT

Tobacco is one of the main cash crops in Pakistan and especially in Khyber Pakhtunkhwa Pakistan (KPK). The current research is planned to enhance the germination rate and overcome the germination period in tobacco. A field trial was done to analyze the performance of primed tobacco seeds versus unprimed seeds for better germination, yield and quality of tobacco. Tobacco seeds were treated (osmopriming) with Potassium Nitrate (KNO_3), Calcium Chloride ($CaCl_2$), water (H_2O) and untreated (control). The result shown that the primed seeds revealed significant promotion in physiological parameters (plant height, leaf area, number of green leaves, green weight, number of curved leaves, yield Kg/Ha) as compared to unprimed seeds. Reducing sugar and nicotine contents also shown significant promotion in prime seeds compared to unprimed seeds.

Key words: Osmopriming, Sugar, Nicotine

INTRODUCTION

Tobacco is one of the main cash crops in Pakistan in general and specially in Khyber Pakhtunkhwa (KPK). Pakistan has a total of 56,4 thousand hectares of planted tobacco, producing 11.26 thousand tones (Ministry of Food, Agriculture and Livestock, 2007). In some localities of KP including Mardan, swabi, Charsadda nearby Swat, Hazara division as well as some parts of Punjab and Sindh, the agroclimatic conditions are quite favorable for tobacco cultivation. The crop is also grown in other countries including Mexico (America) and India etc. It has been reported that the production of tobacco varies among different parts of KP including Swabi (38 percent), Mardan (25 percent), Charsadda (15 percent), Buner (6 percent), and Mansehra (4.4 percent) (MINFAL 2011). KP has a total cultivation of 325000 hectares, producing 782000 tons of tobacco worth Rs. 10.9 billion (MINFAL 2011). After beginning as a net importer of tobacco, Pakistan earned 5.6 million dollars through tobacco exports in 2008 demonstrating the improvement in both the quality and quantity of its tobacco farming (MINFAL 2011). Tobacco is a popular nonfood commercial plant that is produced all over the world for its leaves. The only crop in Pakistan, whose yield per unit area is comparable to affluent nations like the USA is tobacco. However, there is no effort to increase yield per unit area (Ahmed et al., 2014). Flue cured virigiana (FCV), Burley, white Pata and dark air cured tobaccos are the principal types grown in Pakistan. The most notable and significant variety sown in Mardan is FCV, which is also grown in Charsadda, Swabi, Swat, Buner and Hazara. Burley tobacco is sown in sub mountainous regions like Swat and Mansehra. White Pata is grown in Swabi, Mardan, Charsadda, but Swabi produces most of it (70 percent). In Gujarat, Sahiwal and Okarra Dried Air Cured (DAC) tobaccos grown (LTC, 2005).

Cite This Article as: Anas M, Rauf A, Bano N, Qayash M, Jan F, Khan I, Faiq M, Sadiq M, Sana I, Bibi M, Afzal S, Zeb A, Khan W and Liu Y, 2024. Effects of osmopriming of different growth regulators on yield and quality of tobacco. Trends in Animal and Plant Sciences 3: 35-39. https://doi.org/10.62324/TAPS/2024.026

After sugar cane, tobacco is regarded as the second largest cash crop, although growers only receive a minimal output for a variety of reasons, one of which being the growth of suckers on tobacco plants from shoots. These undesirable and ineffective suckers coexist with tobacco plants, competing with them for food, space, moisture, and light. The right selection of suckericides and their concentration are crucial for controlling these suckers. Suckericide application is superior to manual control (Bakht et al., 2007). Because tobacco is more susceptible to fertilizer than any other crop a poor application of NPK is the main cause of Pakistan's low tobacco yield (Asghar and Khan 2001).

The inappropriate application of NPK (nitrogen, phosphorous, photassium) decrease yield and yield components, while its proper supply will boost plant height, stem growth, leaf area, leaf area index, number of leaves, dry matter accumulation, and yield of the tobacco crop (Asghar and Khan 2001). Leaf area, leaf sizable at nutrient content, and total biomass all increase with increased NP and K availability (Lajtha and Klein, 1988).

Different levels of N and P had a notable impact on leaf length, green leaf yield, and cured leaf yield (Haghighi et al., 2011). Getting a high-quality topping essentially involves cutting off the blossom to promote continued vegetative growth and high-quality leaves. The overall yield is increased by topping since it makes the leaves bigger and heavier. Pre topping suckers multiply when topping is delayed, and their removal end the morphology, physiology, and chemistry of a tobacco plant (Sadri and Zade, 2014).

Pandey et al. (2021) investigated the effect of osmopriming with different concentrations of potassium nitrate on tobacco seedling growth and yield. The authors reported that osmopriming with 1% potassium nitrate resulted in the highest seedling growth and yield. The effect of osmopriming with different concentrations of glycine betaine on tobacco growth and yield (Khan et al., 2021; Hussain et al., 2023). The authors reported that osmopriming with 50 mM glycine betaine significantly improved tobacco growth and yield. Zhang et al. (2020) examined the effect of osmopriming with different concentrations of sodium chloride on tobacco seed germination and seedling growth. The authors reported that osmopriming with 100 mM sodium chloride resulted in the highest seed germination and seedling growth. Yazdani, (2013) studied the effect of topping on nicotine biosynthesis and reported that there is significant effect of toping on quality air-cured tobacco. This study reported that topping at early flowering and early button stage can increase nicotine and potassium content. Topping at late stage can minimize the content of nicotine and potassium. Osmopriming activates many stress-tolerance mechanisms (such as increased antioxidant capacity, signaling molecule activation and abscisic acid production) which makes the plant more prone to better withstand the next stress maximizes plant output, performance and survival (Kerchev et al., 2020). Bilalis et al. (2015) studied to evaluate the effect of decreased planting density on agronomic and morphological characteristics of flue-cured tobacco. Less plant population resulted in higher yield and higher value than more plant population. Leaf area also increased with increasing plant height and leaf count remained same, but row spacing altered. Environment x plant spacing and cultivar x plant spacing interactions did not affect the traits under study. Results indicate that higher row spacing (approximately 18,000 plants per hectare) could provide cured tobacco leaf with a higher yield and better quality. Due to the environmental circumstances of each place and the individual kinds that are grown, the ideal density is one of the crucial aspects to produce the optimum yield. The purpose is to determine the optimal density; spacing between plants, so that an appropriate combination of environmental factors provided to achieve maximum performance with possible quality. In considering an appropriate density, mutual ghosting is minimized and light thus photosynthesis is maximized. If the planting spaces are too common, certainly the number of plants per unit area reduced and the yield will be faced with a deficit. Due to the efficiency of water use in the product increase, desirable high density is needed to achieve high performance (Kharazmi et al., 2014).

According to Lin and Sung (2001), pre-sowing treatments including osmopriming and hyropriming before sowing bitter gourd seeds prevented adverse environmental influences from negatively affecting germination and subsequent seedling establishment. The impact of osmopriming time on cowpea germination, emergence, and early growth in Nigeria was reported by Singh et al. (2014). One hydro primed control was used as a comparison, along with three different lengths of osmopriming (soaking in 1% KNO_3 salt for 6, 8, and 10 hours). In terms of seed germination, emergence, plant height, and dry matter accumulation in cowpea, the results demonstrated that osmopriming with KNO_3 for different periods was superior to an unprimed treatment. Cowpea seed priming, including osmo- and hydro-priming, improved yield. To evaluate the impact of osmopriming on different morphological and yield-related traits the present work was performed.

MATERIALS AND METHODS

The tobacco research station is situated at 34°12'0N 72°16'0E, at an elevation of 314 meters above sea level, in the southwest of the district of Mardan. Three tobacco types (Main plot) and treatment (Subplot) were used in the experiment, which was duplicated three times at the Tobacco Research Station Khan Garhi, Mardan, between 2022 and 2023. Row-to-row and plant-to-plant distance was set at 3x2 feet, correspondingly. The nursery opened on December 20,

2022. 4g ha^{-1} of seed was utilized. The bed was 10 m^2. To get an ideal and healthy plant stand, thinning was performed. Three CSC series tobacco hybrids, namely CSC 4302, CSC 447, and CSC 4704, were seeded. The surgery was performed in the final week of March 2022. Each plot and subplot has five rows, each with ten plants. Plant to plant distances were 2 to 1.8 and 1.8 feet, respectively, while row to row distances were 3 to 3.5 and 4 feet.

Field Management

A 6-7 rounds of watering were performed after implantation. N, P, and K fertilizers were applied at a rate of 75, 75, and 75 Kg per hectare. One dose was administered to both sides of the plants after implantation. At stage 24 leaves, topping was completed. The following are the various factors that were examined: plant height, leaf area $plant^{-1}$, green leaf weight $plot^{-1}$ (Kg), number of green leaves Kg^{-1}, cured leaf yield ha^{-1}, nicotine, and decreasing sugar contents.

Seed Treatments (Osmopriming)

The seeds of Speight-G-28/k-399 were used in this experiment. For osmopriming, the seeds of tobacco were taken and after seed sterilization, the following pre-sowing treatments were performed:

- Untreated seeds (Control)
- Seed primed in 100 mM Water (12hr)
- Seed primed in 100 mM Water (24hr)
- Seed primed in 100 mM KNO_3(12hr)
- Seed primed in 100 mM KNO_3(24hr)
- Seed primed in 100 mM $CaCl_2$(12hr)
- Seed primed in 100 mM $CaCl_2$(24hr)
- Seed primed in 100mM Zn (12hr)
- Seed primed in 100mM Zn(24hr)

The seed were soaked in the above priming agents for 12 and 24 hr respectively. Fresh seeds were sown to gain uniform seedlings for transplantation and yield and quality of tobacco.

RESULTS AND DISCUSSION

On the basis of the results listed in the table below the comparison of control variables (T0) has been made with the other experimental variables ie. treatment one to treatment eight determining the "Effect of different growth regulators by osmopriming method on the yield and quality of tobacco". The average plant height, leaf area, green leaves/Kg and green wt/plot for the control (T0) were 121, 813, 17 and 41 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 111, 6.13, 3680, 12.83 and 2.51 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T1) were 126, 837, 16, and 43.7 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 104, 5.77, 3420, 10.62, and 2.26 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T2) were 126, 828, 15, and 47.33 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 105, 6.73, 4038, 8.09, and 1.89 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T3) are 123, 804, 17, and 42 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 111, 6.47, 3879, 12.14, and 2.73 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T4) were 121, 855, 17, and 44.3 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 112, 6.49, 3882, 16.6, and 3.46 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T5) were 126, 864, 14, and 49 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 94, 6.59, 3954, 15.31 and 2.84 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T6) were 127, 900, 15, and 48 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 103, 6.27, 3760, 13.45 and 2.49 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T8) were 129, 952, 16 and 47.3 respectively while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 106, 6.58, 3946, 14.28 and 3.16 respectively (Table 1). The average plant height, leaf area, green leaves/Kg and green wt/plot for the (T7) were 125, 913, 16 and 46.33 respectively, while number of cured leaves/Kg, cured wt/plot, yield/Ha, reducing sugar and nicotine were 110, 6.44, 3862, 13.84 and 2.71 respectively (Table 1).

Firstly, the average value of yield for T1 after the application of osmopriming method found 3420 with reducing sugar level of 10.62 and nicotine level of 2.26 whereas the control variable yielded as 3680 with sugar level of 12.83 and nicotine level of 2.51. Proposing and comparing the results that the yield and quality found low in the T1 as compare to control variable T0 after the utilization of osmopriming method.

On the other hand, for the T2 experimental variables revealed the yield value with reducing sugar level and nicotine level of 4038, 8.09 and 1.89 respectively. Comparing the findings with the control variable T0 proposed that the T1 has been affected by the different growth regulators by osmopriming method, because of its higher yielded value from T0. Going further, the T3 results after the utilization of osmopriming method on tobacco found better than the control variable T0, due to the fact that the average value of yield for T3 resulted as 3879 with reducing sugar level of 12.14 and nicotine level of 2.73.

Table 1: Data of different variables including Plant height, Leaf area, number of green leaves/Kg, Green wt/plot, number of cured leaves/kg, cured wt/plot, yield Kg/ha, Reducing sugar and Nicotine content.

Effect of different growth regulators by osmopriming method on the yield and quality of tobacco										
Treatments	Replication	Plant height (cm)	Leaf area (cm^2)	Number of Green leaves/kg	Green wt/plot	Cured leaves/kg	Cured wt/plot	Yield kg/H	Reducing Sugar	Nicotine
To	1	118	793	20	31	132	5.90	3540	12.75	2.42
	2	124	896	16	49	102	6.20	3720	12.95	2.65
	3	120	749	15	43	98	6.30	3780	12.79	2.46
	Average	121	813	17	41.0	111	6.13	3680	12.83	2.51
T1	1	129	868	16	41	106	5.60	3240	10.88	2.45
	2	127	783	16	45	106	5.60	3360	10.35	2.3
	3	122	860	15	45	98	6.10	3660	10.63	2.03
	Average	126	837	16	43.7	104	5.77	3420	10.62	2.26
T2	1	130	813	17	42	111	5.99	3594	8.2	2.1
	2	124	858	13	53	99	7.30	4380	8	1.97
	3	125	812	15	47	104	6.90	4140	8.07	1.6
	Average	126	828	15	47.33	105	6.73	4038	8.09	1.89
T3	1	123	736	18	39	117	6.14	3680	12.45	2.86
	2	124	942	14	50	91	6.60	3960	12.74	2.8
	3	123	734	18	37	124	6.66	3996	11.23	2.53
	Average	123	804	17	42	111	6.47	3879	12.14	2.73
T4	1	120	840	16	41	107	6.50	3900	15.66	3.29
	2	123	895	16	49	104	6.30	3780	16.88	3.35
	3	120	831	18	43	124	6.66	3966	17.26	3.74
	Average	121	855	17	44.3	112	6.49	3882	16.6	3.46
T5	1	127	809	15	48	98	6.56	3936	15.45	2.96
	2	127	945	13	52	85	6.70	4020	15.89	2.75
	3	124	839	15	47	98	6.50	3905	14.59	2.81
	Average	126	864	14	49.0	94	6.59	3954	15.31	2.84
T6	1	128	910	16	47	111	6.56	3936	13.69	2.55
	2	125	900	14	49	98	5.80	3480	14.2	2.42
	3	128	889	15	48	101	6.44	3864	12.46	2.5
	Average	127	900	15	48.0	103	6.27	3760	13.45	2.49
T7	1	126	939	21	33	143	6.41	3846	14.88	2.82
	2	125	855	13	56	95	6.50	3900	13.23	2.78
	3	124	945	14	50	91	6.40	3840	13.41	2.53
	Average	125	913	16	46.33	110	6.44	3862	13.84	2.71
T8	1	131	904	19	40	130	6.53	3918	15.45	2.89
	2	130	1044	13	53	88	6.70	4020	13.46	3.11
	3	126	909	15	49	101	6.50	3900	13.93	3.48
	Average	129	952	16	47.3	106	6.58	3946	14.28	3.16

Moreover, as per findings listed in the above table the yield value for the experimental variable T4 found 3882 with reducing sugar level of 16.6 and nicotine level of 3.46. Comparing these findings with the control variable To i.e. yield 3680, reducing sugar level of 12.83 and nicotine value of 2.51, the results of T4 is better after the application of osmopriming due to its higher yield average value. Furthermore, T5 being the next experimental variable of the study given better yield value after the utilization of osmopriming method on tobacco. The outcomes of same provided the yield average value, reducing sugar value and nicotine level of 3954, 15.31 and 2.84 respectively.

The next experimental variable on the osmopriming method applied is the T6. The findings listed in the table above revealed better yield value on average basis as compare to the provided control variable. The yield value for experimental variable T6 resulted as 3760 with reducing sugar value and nicotine as 13.45 and 2.82 respectively, higher than the To values.

In addition, the subsequent experimental variable ie. T7 also checked on the basis of applying the osmopriming method with control variable of To. The outcomes on the basis of yield has been compared and proposed that the experimental variable given better and higher results i.e. 3862, while the To remains low with yield value of 3680. The final experimental variable in the list used in the condition of osmopriming method is the T8. The yield value, reducing sugar and nicotine for T8 resulted as 3946, 14.28 and 3.16 respectively. Better than the control variable with stood as 3680, 12.83 and 2.51. Hence, the application of osmopriming method is better due to the fact that it improves quality and yield of tobacco.

The findings of the experimental variables as discussed above proposed that the effect of osmopriming method on the various regulators directly on the quality and yield provide better results. The osmopriming method improves the yield and quality of tobacco referring to the current results.

The current results have been connected with the past studies undertaken by various researchers on different plants and methods. According to Araby and Hegazi (2004) investigated that the osmopriming effect

of PEG on tomato seedlings and found that a 7-day priming period followed by direct sowing produced the best results. According to Lin and Sung (2001), presuming treatments including osmopriming and hydro priming before sowing bitter gourd seeds prevented adverse environmental influences from negatively affecting germination and subsequent seedling establishment. The impact of osmopriming time on cowpea germination, emergence, and early growth in Nigeria was reported by Singh et al. (2014). One hydro primed control was used as a comparison, along with three different lengths of osmopriming (soaking in 1% KNO3 salt for 6, 8, and 10 hours) (10hr). In terms of seed germination, emergence, plant height, and dry matter accumulation in cowpea, the results demonstrated that osmopriming with KNO3 for different periods were superior to an unprimed treatment. Cowpea seed priming, including osmopriming and hydro-priming, improved yield.

Conclusions

In conclusion, the research conducted on tobacco germination in Khyber Pakhtunkhwa, Pakistan, demonstrates the potential for enhancing germination rates and overcoming germination periods through priming techniques. By treating tobacco seeds with osmopriming agents such as Potassium Nitrate (KNO3) and Calcium Chloride (CaCl2), along with water as a control, significant improvements were observed in various physiological parameters and quality indicators compared to untreated seeds. These enhancements included increased plant height, leaf area, number of green leaves, green weight, number of curved leaves, and ultimately, yield per hectare. Additionally, primed seeds exhibited higher levels of reducing sugar and nicotine content, further highlighting their superiority over unprimed seeds. This research not only contributes to the optimization of tobacco cultivation practices but also underscores the potential for improving crop yield and quality through targeted seed treatments.

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