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Assessing Impact of Manual Topping and Suckericide Application at Different Stages on FCV Tobacco Quality and Yield

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ABSTRACT

Tobacco (*Nicotiana tabacum* L.) topping is one of the essential practice to obtain good quality and adequate yield. The suckericide (Flumetralin as a best herbicide and plant growth regulator). For the purpose to compare topping as manual and herbicide application the experiment was conducted on flue cured Virginia (FCV) tobacco at Tobacco Research Station, Khan Ghari, Mardan during 2021-2022. The experiment was conducted in RCB design with three replications and five treatments (Control, Manual de-suckering, 1000, 1200, 1500 ml of Flumetralin ha^{-1}). Treatments were applied at three stages (button stage, early flowering stage and late flowering stage). The data revealed that topping timing and maximum dose (1500 ml ha^{-1}) of (Flumetralin) resulted maximum (896 cm^{-2}) leaf area, less number (14) of sucker $plant^{-1}$, lower (132 g) green weight and dry weight (20.30 g) of sucker $plot^{-1}$, more cured weight (5.08 kg) of leaves $plot^{-1}$ and maximum yield (3038) kg ha^{-1}, lower nicotine contents (2.26) and less sugar contents (16.24) at button stage. Moreover, Flumetralin application on at button stage resulted less sucker growth and enhanced leaf yield. I suggest that the tobacco K399 with the application of suckericide and growth regulator (Flumetralin) have the potential to incorporate in further breeding program for low content of nicotine, reduced sugar content and high yield.

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Introduction

Tobacco (*Nicotiana tabacum* L.) is one of the most important cash crop of Pakistan, which contributes to the development of economy. Tobacco was grown in Pakistan, on about 50,800 hectares with production of about 113.6 million kilograms (PTB 2021). Tobacco is mainly cultivated for obtaining leaf because the leaf is manufacturing food material which is utilized in growth processes.

Topping (removal of the flowering head and young leaves) is an essential cultivation measure for tobacco growers, which switches off the plant from reproductive to vegetative phase (Gooden et al., 2011). Topping increases the size and weight of leaves, increasing the overall yield per hectare (Reed et al., 2012).

To encourage and maximize the leaf production and leaf ripening it is compulsory operation to remove the flower from the plant. The benefits of removing flower, switches off the plant from the seed production/reproductive phase to vegetative stage and it also enhancing leaf production/ vegetative phase (Pandeya et al., 2001; Wange et al., 2012).

Topping increases the size and weight of leaves, increasing the overall yield per hectare (Roton et al., 2005). The main aim of topping is to convert all the essential nutrients of the plant to the leaves instead of flowers and seeds which resulted of receiving in the large and better size of the tobacco leaf. It also provides proper and uniform quality of product and prevents extreme coarseness in the leaves (Wang et al., 2012).

In tobacco there are three important stages of topping operation i.e. button stage, early stage and late stage. Button stage is very imperative and economical stage of topping because it reduces weight from the top of the plant, increases root growth by reducing the movement of moisture and nutrient from lower leaves to support upper leaves, increase the nicotine contents and leaf size and therefore promote overall yield per hectare and especially for improve the plant growth, development and quality (Sadri and Zade et al., 2014).

For getting good quality yield from tobacco crop de-suckering is a compulsory process. Removing these suckers by hand is very laborious and time consuming job (Bakht et al., 2007). While chemical topping appears to be the ideal for removing excess leaves and the top which become flower in future. Therefore, in the current study we will investigate the influence of suckericide (Flumetralin) and manual topping on tobacco crop at different stages.

Material and Methods

A field experiment was conducted to check the influence of Flumetralin suckericide having different concentration at different growth stages of FCV tobacco K399 to evaluate the yield and quality. The research was laid out in RCB design having five treatments and three replications at Tobacco Research Center Khan Garhi Mardan during 2021-22, having a humid subtropical, no dry season climate average temperature is 18.06ºC (64.51ºF) and it is -2.83% lower than Pakistan's averages typically receives about 121.24 millimeters (4.77 inches) of precipitation and has 133.98 rainy days (36.71% of the time) annually. Soil is mostly silty loam with 8.0 to 8.3 pH and 0.10 to 0.17 (DSM^{-1}) electrical conductivity. Total soluble salts are in the range of 0.032 to 0.054%. CaCO3 is with a range of 6.50 to 9.0.and 0.62 to 0.89 % with organic matter content. Plants were sown in 90 cm row to row distance and 60 cm plant to plant distances. Plot size was 4×5 m^2 having 3 rows, and each row was 6 m long which was consists ten plants. The total research plot size was 300 m^2. In December, 2021 the nursery was raised for transplantation and transplanted during the first week of March, 2022. Data were recorded on leaf area (cm^2), number of suckers' $plant^{-1,}$ green weight (kg) of suckers' $plot^{-1,}$ dry weight of sucker $plot^{-1}$, cured weight of leaves plot (kg), Yield (kg ha^{-1}), Nicotine (%) and Reducing sugar (%)

The following treatment combination were used:

T_0 = Control

T_1 = Manual de-suckering

T_2 = 1000 ml ha^{-1} (Minimum dose)

T_3 = 1200 ml ha^{-1} (Optimum dose)

T_4 = 1500 ml ha^{-1} (Maximum dose)

These all five treatments were applied three times at button stage, early stage and late stage.

Statistical Analysis

The data were analyzed by using ANOVA and the methods described by (Jan et al., 2009) and for means comparison between the treatments least significant difference ($P \leq 0.05$) test were used.

Result and Discussion

Leaf Area (cm^2)

Different time of topping, and suckericide concentration extensively influenced the leaf area of tobacco crop. Maximum leaf area (1015.3 cm^2) with highest dose, (968 cm^2) with moderate dose followed by minimum dose and manual de-suckering, at button stage of topping (Table 1). The lowest leaf area (701.1 cm^2) was recorded from plots that were manually de-suckered at late flowering stage. The Interaction between maximum dose of Flumetralin and button stage topping indicated maximum leaf area in comparison with those plots which were manually de-suckered. It means that increasing suckericide concentration lead to increased leaf area of tobacco plant. Former findings of (Singh et al., 2000) reported that timely topping is an important operation for suckers control and to obtain better leaf area in tobacco crop. The earlier results of (Mahadevareddy et al.,1986) also noted that utilization of chemical suckericide have the best sucker control and leaf yield.

Number of Suckers' $plant^{-1}$

Number of suckers' $plant^{-1}$ were significantly affected by topping time and Flumetralin concentration. Plants where topping was done at button stage produced lowest sucker $plant^{-1}$ by maximum dose of Flumetralin (3.6) followed by optimum dose at button stage (8). Topping at later flowering stage have resulted highest sucker $plant^{-1}$ (32.6) by manual de-suckering. The interaction between the Flumetralin concentration and topping stages were significant as shown in (Table 2). Higher Flumetralin concentration application at button stage has resulted in better cover of plant and reduced new suckers' growth compared with late stage. The researcher (Farrokh et al., 2012) noted that topping plays a pivotal role in triggering the production of secondary plant compounds that gather in the foliage, making it imperative to perform this operation promptly in order to manage the growth of suckers effectively.

Green Weight (kg) of Suckers' $plot^{-1}$

Different time of topping and suckericide concentration significantly affected fresh weight of suckers. Interaction of maximum dose of Flumetralin at button stage of topping were also founded significant.

Table 1. Leaf area (cm^2) as effected by manual topping and suckericide application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	937	852.3	747.3	845.6 cd
T1 (Manual de-suckering)	941.7	826.7	701.1	823.3 d
T2 (Minimum dose)	951.3	859.3	765	858.6 bc
T3 (Optimum dose)	968.3	865.3	781.3	871.7 b
T4 (Maximum dose)	1015.3	884.3	788.3	896 a
Mean	962.7 a	857.6 b	756.7 c	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05.; Least significant difference value for treatments at 0.05 level = 17.34; Least significant difference value for treatments at 0.05 level = 13.43

Table 2. Number of suckers per plant^{-1} as affected by manual topping and suckericide application at different stage on FCV tobacco quality and yield

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	28.6	33.3	34.3	32.1 a
T1 (Manual de-suckering)	27	31.6	32.6	30.4 a
T2 (Minimum dose)	19.6	26.3	21.3	22.4 b
T3 (Optimum dose)	8	22	23.6	17.8 c
T4 (Maximum dose)	3.6	19	20.6	14.4 d
Mean	17.4 b	26.4 a	27 a	

Mean values in the same category, marked by different letters, demonstrate statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05.; Least significant difference value for treatments at 0.05 level = 1.86; Least significant difference value for treatments at 0.05 level = 1.44

Table. 3 Green weight of suckers per plot^{-1} as affected by manual topping and suckericide Application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	215	247	255	239 a
T1 (Manual de-suckering)	180	234	238	217 b
T2 (Minimum dose)	144	188	191	174 c
T3 (Optimum dose)	99.3	170	175	148 d
T4 (Maximum dose)	72.7	160	163	132 e
Mean	142 b	200 a	204 a	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 11.66; Least significant difference value for treatments at 0.05 level = 9.03

Table. 4 Dry weight of sucker per plot^{-1} as affected by manual topping and suckericide Application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	34.93	38.04	39.22	37.40 a
T1 (Manual de-suckering)	29.99	35.99	36.56	34.18 b
T2 (Minimum dose)	22.09	28.92	29.43	26.81 c
T3 (Optimum dose)	15.27	26.16	26.92	22.78 d
T4 (Maximum dose)	11.17	24.61	25.12	20.30 e
Mean	22.69 b	30.74 a	31.45 a	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 1.87; Least significant difference value for treatments at 0.05 level = 1.45

Plots treated with maximum dose of Flumetralin resulted minimum green weight (72.7 g) followed by optimum dose at early flowering stage (99.3). Maximum green weight of suckers (238 g) was recorded in plots where manual de-suckering was done (Table 3). The results were supported by (Hao et al., 2001) who reported that topping stage of tobacco is vital and necessary for key time and improvement of agricultural measures to encourage the quality of leaves and late topping increase the number of pre-topping suckers that must be removed as well as the chance of plants blowing over in a windstorm.

Dry Weight of Sucker plot^{-1}

Analysis of data showed significant disparity of the effect of topping stages with different doses of Flumetralin on the dry weight of sucker plot^{-1}. Lowest dry weight of suckers was found in those plots where topping was done at button stage followed by early stage. The maximum dry weight of sucker plot^{-1} was recorded in control (39.22 g), followed by manual de-suckering in later flowering stage (36.56) and early flowering stage (35.99). Interaction was also founded significant as shown in (Table 4). The dry weight of sucker's plot^{-1} appreciably decreased with an increased in the Flumetralin concentration and treated at button stage of topping compare with control plots. These results were in same channel with the results presented by (Pandeya et al., 2001) who noted that chemical suckericide had important consequence on suckers control and give minimum dry weight of sucker's plant^{-1}.

Cured Weight of Leaves plot (kg)

Topping time and suckericide concentration significantly affected the cured weight of leaves plot^{-1} (Table 5). The highest cured leaves weight (5.51 kg) was recorded in those plots with manual de-suckering, followed by (5.51 kg) with the application of maximum dose and (5.46 kg) with optimum dose of Flumetralin at button stage. The lowest cured weigh was found in control plots. Interaction was also significant at button stage compare with control and late stage of topping presented in (Table 5). The results were also supported by (Wang et al., 2012) who concluded that the aim of topping is to divert the vital nutrients of the plant to the leaves instead of their seeds and flower with the consequences of gaining length and width of the leaf.

Yield (kg ha^{-1})

Analysis of data revealed that the Flumetralin concentration on topping stages influencing yield significantly. The higher yield was founded in plots which were treated by optimum dose of Flumetralin at button stage (3278. kg ha^{-1}) followed by maximum dose of Flumetralin at button stage (3275 kg ha^{-1}).

Table. 5 Cured weight of leaves per plot^{-1} (kg) as affected by manual topping and suckericide application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	5.31	4.71	4.36	4.79 c
T1 (Manual de-suckering)	5.51	4.77	4.44	4.91 b
T2 (Minimum dose)	5.37	4.85	4.4	4.90 b
T3 (Optimum dose)	5.46	4.99	4.56	5.01 a
T4 (Maximum dose)	5.51	5.09	4.63	5.08 a
Mean	5.43 a	4.88 b	4.49 c	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 0.075; Least significant difference value for treatments at 0.05 level = 0.058

Table. 6 Yield (kg ha^{-1}) as affected by manual topping and suckericide application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	3189.2	2830	2620	2879.7 e
T1 (Manual de-suckering)	3210	2865	2666.7	2913.8 d
T2 (Minimum dose)	3226.6	2915.7	2684	2942.1 c
T3 (Optimum dose)	3278.3	3000	2741.7	3006.7 b
T4 (Maximum dose)	3275	3059	2780	3038 a
Mean	3235.8 a	2933.9 b	2698.4 c	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 16.956; Least significant difference value for treatments at 0.05 level = 13.136

Table. 7 Nicotine (%) as affected by manual topping and suckericide application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	2.34	2.29	2.27	2.29 b
T1 (Manual de-suckering)	2.5	2.27	2.3	2.35 d
T2 (Minimum dose)	2.27	2.25	2.8	2.43 a
T3 (Optimum dose)	2.27	2.2	2.81	2.42 ac
T4 (Maximum dose)	2.03	2.15	2.62	2.26 b
Mean	2.23 b	2.26 b	2.56 a	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 0.171; Least significant difference value for treatments at 0.05 level = 0.132

Table. 8 Reducing sugar (%) as affected by manual topping and suckericide application at different stage on FCV tobacco quality and yield.

Treatments	Button stage	Early stage	Late stage	Mean
T0 (control)	7.18	7.4	7.01	7.19d
T1 (Manual de-suckering)	15.45	15.4	15.4	15.41 c
T2 (Minimum dose)	15.44	15.5	15.46	15.47 b
T3 (Optimum dose)	15.44	15.45	15.45	15.44 bc
T4 (Maximum dose)	16.29	16.26	16.19	16.24 a
Mean	13.96 b	14.0 a	13.90 c	

Mean values in the same category, marked by different letters, demonstrate a statistically significant distinction from one another, as evidenced by the LSD test, with a significance level of P<0.05; Least significant difference value for treatments at 0.05 level = 0.045; Least significant difference value for treatments at 0.05 level = 0.034

The lower yield was achieved in check plots in late flowering stage. Interaction of topping time and suckericide concentration were also founded significant. (Wang et al. 2012) reported similar result that to persuade leaf ripening and maximize and courage the leaf production, it is compulsory to control and remove the flower. The aim of removing the flower from the tobacco plant switch off the plant from a reproductive stage to a leaf producing phase.

Nicotine (%)

The lowest nicotine content is an important characteristic for receiving good quality of tobacco leaves. Data regarding nicotine (%) presented in (Table 7) showed that topping time and Flumetralin concentration significantly affected nicotine percentage. The lowest nicotine (%) was founded in those plots which were treated with maximum dose of Flumetralin at button stage (2.03%), followed by control plots with no sprayed of Flumetralin. The highest nicotine (2.81 %) were founded

in plots which were treated with optimum dose of Flumetralin at late flowering stage. The interaction between topping time and concentration were also founded significant. Similar results were also reported by (Mahadevareddy et al. 1990) that the using of 10% ILTD mixture decreased nicotine contents in leaf.

Reducing Sugar (%)

The data about topping and Flumetralin concentration significantly affected reducing sugar (%) in tobacco leaf. The lowest reducing sugar (7.18%, 7.4%, 7.01%) at button, early and late flowering stage respectively, founded in control plot having no sprayed of Flumetralin. Interaction between topping time and Flumetralin concentration indicated that reducing sugar (%) increases with increasing concentration of Flumetralin concentration compared to control plot having no sprayed of Flumetralin. (Mahadevareddy et al. 1990) also reported that 10% ILTD mixture increased nicotine contents and enhanced the reducing sugar contents in tobacco leaf.

Conclusion

Topping in tobacco is one of the most important and vital operations to improve leaf growth, development and quantity. Moreover, application of maximum dose of suckericide; Flumetralin at button stage was more effective in tobacco. The results obtained from the present study indicated that topping at button stage and suckericide concentration (1500 ml ha^{-1}) were more effective for better suckers control, enhanced leaf quality, increases leaf area, better cover of plant, reduced new suckers' growth, minimized green weight of suckers, decreased dry weight of sucker's $plot^{-1}$. The optimum concentration dose (1200 ml ha^{-1}) enhanced nicotine concentration, increased sugar contents, and yield of tobacco crops.

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