EFFECT OF POTASH LEVELS AND TOPPING ON LEAF POTASSIUM, YIELD AND QUALITY IN FLUE CURED TOBACCO

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SUMMARY

Potassium is the most important plant nutrient and is taken up by tobacco plant in large quantities. Pot culture experiments conducted using light soil with different K levels in combination with topping and no topping showed increased yield of green leaf, cured leaf and grade index. Green leaf yield was at par in 80 to 600 kg/ha K level and was significantly higher than 0 kg/ha and 800 kg/ha of K gave higher yield than others. Cured leaf yield was on par in 80 and 200kg/ha K, but significantly higher than 0 kg/ha and 400 kg/ha gave higher yield than at the lower three levels but was similar to that at 600 kg/ha K. 800 kg/ha K gave significantly higher yield than at 0, 80, 200 and 400 kg/ha but was equal to that at 600kg/ha K. Grade index was higher in 600 and 800 kg/ha K than other treatments. Topping increased yield more than the control. Interaction between K and topping was significant for grade index. Under both topping and control 600 and 800 kg/ha gave higher grade index than other treatments. K deficiency symptoms appeared especially more severely in untopped plants when K was withheld. Leaves from topped plants contained higher K than in untopped plants. Application of increasing levels of K increased K and decreased Ca content in cured leaves. Higher levels of K gave higher leaf K content in leaves than in younger ones. On the other hand Mg content decreased with higher K content in general. Analysis of cured leaves showed that nicotine, reducing sugars and chlorides were not affected by K. Leaf burn was low in 0 kg/ha K but increased with increasing levels of K. Leaf thickness generally decreased with higher doses of potash and topping increased thickness as compared to no topping. It is concluded that potash application above 600 kg/ha improved yield characters and leaf potassium, calcium, leaf burn and thickness were significantly affected by potash levels and topping.

INTRODUCTION

Tobacco plant needs ample quantities of potassium for its normal growth and metabolism but its fair distribution in leaves from all the stalk positions is required for maintaining the leaf quality. Higher leaf potassium content improves burn (Pal *et al* 1966) and reduces smoke nicotine, tar and carbon monoxide (Yamamoto *et al* 1990). Distribution of K in the plant is influenced by its availability in the root zone (Chouteau and Reiner 1960). Flue cured tobacco growing soils of Andhra Pradesh are classified medium to high in available K status (Krishnamurthy *et al.* 1984) and exportable type of flue cured tobacco is grown in alfisols of West Godavari district and potassium deficiency occurs (Krishnamurthy and Ramakrishnayya 1986) with low or no application of potash fertilization. Production of flue cured tobacco with higher leaf K content is of utmost importance from the point of view of its usability for smoking as it determines the rate of leaf burn and chemical quality of the leaf. Higher potassium in

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the leaf reduces tar and nicotine content and carbon monoxide deliveries of the smoke and makes the cigarettes less harmful to the smoker. In view of this it is desirable to increase the potassium content in the leaf and with this aim, a study was conducted with different levels of potash fertilizer for its effect of yield, quality and leaf K content.

MATERIALS AND METHODS

A pot culture trial was conducted with flue-cured tobacco *nicotiana tobacum* cv McNair-12 using light soil (Alfisol). Six levels of potash application viz. 0, 80, 200, 400, 600, and 800 kg/ha were applied in a randomized block design with 20 replications with topping and no topping. 50kg capacity pots were filled with light soil and basal dose of N, P and K fertilizers were applied. Pots were irrigated and uniform healthy seedlings were transplanted. The remaining doses of fertilizers were given as per the schedule. Nitrogen and phosphorus were applied @ 60 and 80 kg/ha dose, respectively and phosphorus was applied in two equal splits, one as basal and second application on 30^{th} DAP (days after planting). Nitrogen was applied in three equal splits viz. basal, 20^{th} and 30^{th} DAP. Pots were irrigated whenever the plants showed wilting symptoms. From the 55^{th} DAP flower buds started appearing and when all the plants entered the flowering , topping was done at elongated bud stage keeping uniformly 18 leaves on the plant and the suckers were controlled with a chemical suckericide. In plants which were not topped flower heads were allowed to develop fully. Leaves from mid stalk position were collected on 60^{th} DAP from all the treatments for estimation of potassium. At the time of topping, bottom sand leaves turned yellow and dried. These leaves were removed at weekly intervals. Harvested leaves were cured in the electrical barn and yield parameters green leaf, cured leaf and grade index were recorded. These leaf samples were analysed for leaf potassium (Ramakrishnayya and Krishnamurthy, 1990) and calcium (Jackson 1967) on plant position basis and composite samples were analysed for magnesium (Jackson, 1967). Chemical quality parameters, nicotine and sugars (Harvey, Starch and Smith 1969) and chlorides (Hanumantha rao *et al.* 1980) were estimated in composite samples of cured leaf. Cured leaf physical attributes viz., leaf burn (Venkataraman and Tejwane 1957) and leaf thickness were also determined. Data were analysed statistically (Panse and Sukhatme 1967).

RESULTS AND DISCUSSION

Potassium is the most important plant nutrient in tobacco production system and the plant takes it up in large quantities (Rapar, Jr. and McCants 1966). Amount of potash fertilizer used often exceeds normal yield requirements. Krishnamurthy and Ramakrishnayya (1982) reported that potash application up to 300 kg/ha improved cured leaf yield and quality of flue cured tobacco. Positive aspects of higher leaf potassium were reported and our investigations showed that potash levels increased yield characters green leaf yield, cured leaf yield and grade index (Table 1). Green leaf yield was on par at 80 and 400 kg/ha K and was higher than 0 kg K/ha although it was significantly higher at 600 and 800 kg/ha K. Cured leaf yield was constant at 80 and 200 kg/ha but significantly higher than 0 kg. 400 kg/ha gave higher yield as compared to lower three levels but on par with 600 kg/ha. 800 kg/ha K gave higher yield as compared to 0, 80, 200 and 400 kg/ha but is on par with 600 kg/ha K. Grade index was higher in 600 and 800 kg/ha K as compared to all other treatments. Topping significantly improved yield characters as compared to without topping. The interaction of K levels and topping was significant for grade index. Under no topping cured leaf yield increased above 400 kg/ha K level but was on par in 80 and 200 kg/ha K level and higher as compared to 0 kg/ha. But with topping, yield levels in 0 to 200 kg/ha were on par and 400, 600 and 800 kg/ha levels gave higher yield as compared 0 to 200 kg/ha K levels. Leaf potassium data (Fig. 1) supports the yield differences in topped and untopped plants as in topped plants yield was at par in 0, 80 and 200 kg/ha since the potassium taken up by the plant was utilized for limited number of leaves on the plant as compared to mobilization of potassium to the flower head and more number of leaves in untopped plants and hence per leaf potassium availability was more in topped plants as compared to un topped plants under limited supply of potassium (0 kg/ha) from the soil. Topped and untopped plants showed initial K deficiency symptoms around 40 DAP in bottom leaves but these symptoms become aggravated in untopped plants as compared to topped plants. Leaf K content estimated on 60^{th} DAP shows clearly the low leaf K

Table 1. Effect of different levels of potash on yield and quality in FCV tobacco.

Potash levels (kg/ha)	Yield characters (g/plant) Green leaf Topped	Green leaf Untopped	Green leaf Mean	Cured leaf Topped	Cured leaf Untopped	Cured leaf Mean	Grade index Topped	Grade index Untopped	Grade index Mean
0	443	396	419	102	75	88	62	40	51
80	459	420	440	105	80	93	71	44	57
200	464	418	441	105	82	94	69	44	56
400	459	432	445	111	88	99	68	45	57
600	498	427	462	117	87	102	84	46	65
800	573	511	542	121	88	105	87	45	66
Mean	483	434		110	83		73	44	
	T	K	T x K	T	K	T x K	T	K	T x K
S.Em±	5	8	11	1.0	1.8	2.5	1.1	1.9	2.6
C.D. (0.05)	13	22	NS	2.8	4.9	NS	3.0	5.2	7.3

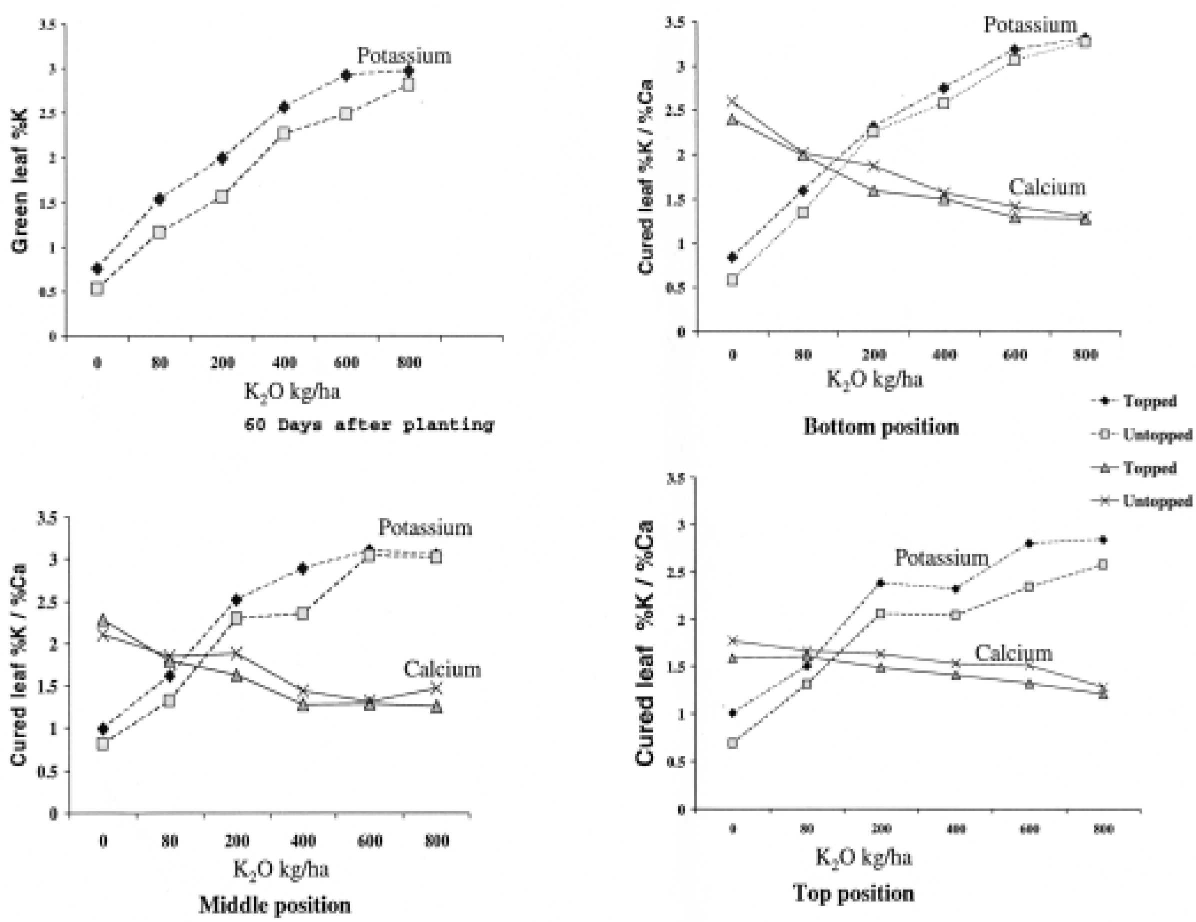

Fig. 1. Effect of potash levels, topping and leaf position on leaf K and Ca content

content in untopped plants as compared to topped plants (Fig. 1). Earlier work on potassium nutrition shows that plant takes up K from planting to two weeks before harvesting and this will be sufficient to meet the further potassium requirement of the plant (Flower, 1999). This was evident from the leaf K data (Fig. 1). Under no topping cured leaf K was low in 0 to 200 kg/ha (Fig. 1) but the same K leaves gave higher cured leaf K in topped plants as it was distributed in less number of leaves. But with higher doses of 400 kg/ha and above the leaf K was similar in both topping and no topping. Leaf K content influenced the Ca content as both the nutrients have negative relation. Low K content in untopped plants resulted in higher Ca as compared to topped plants with low K levels but as the K dose increased leaf K increased both in topped and untopped plants and Ca content decreased significantly (Fig. 1). Observations during plant growth showed that with 0 kg/ha potash application leaves showed the typical potassium deficiency symptoms and the leaf lamina content of K estimated at 60^{th} DAP showed 0.76% and it increased to 2.77% in 600 kg/ha (Fig. 1). McMurtrey (1964) reported that leaf potassium concentration of less than 1% results in deficiency symptoms. Cured leaf chemical composition showed that % K was lowest in 0 kg/ha potash dose and it increased linearly to maximum in 800 kg/ha. Leaf position on the stalk influenced the K content of the leaves. At lower levels of potash application top position leaves contained higher and bottom leaves contained lower % K, but with increasing dose of potash the trend was reverse and leaf K was higher in bottom position as compared to leaves from top position. Earlier work with moderate fertilization also showed that K was distributed uniformly in all the leaf positions but high rates promote accumulation in the lower leaves (Gribbins 1941). Topping effect on leaf K content was not significant. Percent calcium in the leaf decreased with increase in potassium content and the bottom leaves contained higher % calcium as compared to top leaves and Elliot (1968) also reported higher calcium content in leaves from bottom stalk position. Topping has no significant effect on the content of calcium and magnesium in cured leaf. Potash levels did not affect leaf nicotine, reducing sugars or chloride content at all the three leaf positions but nicotine increased from bottom to top stalk position in ascending order independent of potash level (Table 2). Topping increased cured leaf nicotine content and decreased reducing sugars as compared to no topping. Topping increased leaf thickness (Table 4) and reduced leaf burn (Table 3). Leaf thickness generally decreased with higher doses of potash and topping increased thickness as compared to no toping. The interaction effect of topping and K levels for leaf thickness was not consistent. Increasing levels of potash decreased leaf thickness and increased leaf burn. Leaf burn was low

Table 2. Effect of different levels of potash and topping on leaf chemcial composition.

Potash levels (kg/ha)	Cured leaf chemical composition (%) Nicotine			Reducing sugars			Chlorides		
	Topped	Untopped	Mean	Topped	Untopped	Mean	Topped	Untopped	Mean
0	1.42	1.38	1.50	20.16	19.14	19.65	0.34	0.40	0.37
80	1.49	1.37	1.43	21.48	24.36	22.92	0.36	0.28	0.32
200	1.65	1.16	1.40	18.57	24.39	21.48	0.35	0.23	0.29
400	1.16	1.19	1.17	20.64	21.98	21.31	0.30	0.41	0.36
600	1.29	1.19	1.24	23.05	21.86	22.46	0.25	0.33	0.29
800	1.44	1.21	1.32	20.17	20.07	20.12	0.39	0.49	0.44
Mean	1.41	1.29	1.27	20.68	21.97	21.32	0.33	0.36	0.34
	T	K	T x K	T	K	T x K	T	K	T x K
S.Em±	0.07	0.12	0.20	0.57	0.99	1.40	0.04	0.07	0.10
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Effect of different levels of potash, topping and leaf position on leaf burn.

Potash levels (kg/ha)	Leaf burn (Seconds) Bottom Topped	Bottom Untopped	Bottom Mean	Middle Topped	Middle Untopped	Middle Mean	Top Topped	Top Untopped	Top Mean
0	0.65	1.07	0.86	2.54	2.41	2.48	1.99	4.14	3.07
80	3.04	3.55	3.29	3.48	3.96	3.72	2.99	2.90	2.94
200	4.64	4.83	4.74	4.09	4.74	4.42	2.86	3.55	3.20
400	5.04	4.21	4.62	4.61	5.43	5.02	3.99	5.51	4.75
600	3.57	5.19	4.38	5.81	6.03	5.92	4.92	6.10	5.51
800	6.22	6.33	6.28	6.69	9.52	8.10	5.72	6.77	6.25
Mean	3.86	4.53		4.54	5.35		3.74	4.83	
	T	K	T x K	T	K	T x K	T	K	T x K
S.Em±	0.32	0.19	0.46	0.16	0.09	0.22	0.15	0.09	0.21
C.D. (0.05)	0.89	0.52	1.28	0.43	0.25	0.62	0.41	0.24	0.58

Table 4. Effect of different levels of potash, topping and leaf position on cured leaf.

Potash levels (kg/ha)	Leaf thickness (0.01 mm) Bottom Topped	Bottom Untopped	Bottom Mean	Middle Topped	Middle Untopped	Middle Mean	Top Topped	Top Untopped	Top Mean
0	9.34	6.82	8.08	7.54	6.67	7.11	9.12	5.81	7.47
80	10.06	12.06	11.56	6.91	5.56	6.23	14.29	6.94	10.62
200	9.92	7.16	9.54	5.94	4.63	5.28	9.84	6.64	8.24
400	7.12	5.84	6.48	5.42	4.59	5.01	9.77	5.90	7.84
600	5.00	5.79	5.40	3.93	2.89	3.41	11.72	6.03	8.77
800	5.81	6.80	6.31	4.69	3.31	4.00	8.97	3.59	6.28
Mean	8.37	7.41		5.74	4.61		10.62	5.82	
	T	K	T x K	T	K	T x K	T	K	T x K
S.Em±	0.39	0.23	0.55	0.13	0.08	0.18	0.25	0.15	0.36
C.D. (0.05)	1.1	0.63	1.53	0.36	0.21	NS	0.70	0.40	0.99

in 0 kg/ha potash and it increased with increasing level of potash application and burn was higher in mid stalk lamina as compared to top position. Increased potassium content in the leaf was responsible for improved burning and Pal *et al.* (1966) have reported higher rates of leaf burn with increased leaf K content. The other possible reasons for higher burn was decrease in cured leaf thickness with increasing level of Potash application (Table 4). It is concluded that potash application above 600 kg/ha improved yield characters cured leaf yield and grade index and leaf potassium, calcium, leaf burn and thickness were significantly affected by potash levels and topping.

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