



## Study effects of different nitrogen and potassium fertilizers application amounts on quantitative and qualitative characteristics of tobacco (male sterile variety, PVH<sub>19</sub>) in Talesh region

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### ABSTRACT

For study effects of nitrogen and potassium fertilizers on quantitative and qualitative characteristics of tobacco (male sterility variety PVH<sub>19</sub>) an experiment in factorial format based on randomized complete block design with 3 replications in Dyrakary Mahale Jvkandan Village (Talesh Township in Guilan Province located in north of Iran) in 2011 farming year was conducted. Factors of experiment were consisting of nitrogen fertilizer with three levels (N<sub>1</sub>: 0 (control), N<sub>2</sub>: 34.5 and N<sub>3</sub>: 69 kg pure nitrogen/ha from source of ammonium nitrate respectively 0, 100 and 200 kg/ha application) and potassium fertilizer with four levels (K<sub>1</sub>: 0 (control), K<sub>2</sub>: 75, K<sub>3</sub>: 150 and K<sub>4</sub>: 225 kg potassium oxide /ha from source of potassium sulfate respectively 0, 150, 300 and 450 kg/ha application). Measured traits were included leaf length, leaf width, number of leaves, stem diameter, plant height, leaf area index, fresh leaf yield, dry leaf yield, the average price, gross income, leaf chlorophyll content, nicotine content on priming, cutter and tip leaf, sugar content on priming, cutter and tip leaf, nitrogen content on priming, cutter and tip leaf, potassium content on priming, cutter and tip leaf. Results of data analysis showed that, the highest dry leaf yield between nitrogen fertilizer levels with 4501 kg/ha was recorded from 69 kg nitrogen/ha treatment. On the other hand, among potassium fertilizer application levels, the highest dry leaf yield with 4238 kg/ha was obtained from 225 kg potassium/ha usage. Between interaction treatments, the N<sub>3</sub>K<sub>4</sub> level with 4975 kg/ha dry leaf yield was superior.

**Keywords:** Nitrogen, Potassium, Tobacco, Yield, Talesh, Iran

### INTRODUCTION

Tobacco with scientific name of (*Nicotiana tabacum* L.) belong to Solanaceae family is one of the important industrial crops in the world that plays a critical role in economy of producing countries and its income from various products had a major share of the national income. Tobacco is an annual, short day length and self pollinated crop that its chromosomal number is 2n=48 [20].

The yield of plants depends upon several production factors. Among these proper, balanced nutrition plays a significant role. Among the nutrient requirements of plants, nitrogen and potassium are two essential elements for plant growth and directly interact and affect the growth and development [15]. The main purpose of fertilization in tobacco plants not only the quantity but quality should be considered.

Nitrogen is considered as one of the essential macronutrients required by the plants for their growth, development and yield [21]. Nitrogen deficiency generally results in stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with abundant dark green (high chlorophyll) tissues of soft consistency and relatively poor root growth. This increases the risk of lodging and reduces the plants resistance

to harsh climatic conditions and to foliar diseases [22]. Nitrogen (N) fertilizer use has played a significant role in increase of crop yield [2]. Aminifard *et al.*, (2010) with study responses of eggplant to different rates of nitrogen under field conditions were reported that fertilization with 100 kg nitrogen/ha resulted in the highest average fruit weight and fruit yield [14]. Bozorgi *et al.*, (2011) with study effects of nitrogen fertilization on seed yield and several attributes of peanut was reported that the highest seed yield was obtained by 80 kg nitrogen/ha [11]. Postini and Shamel Rostami (2000) with study physiological and agronomical responses of tobacco to nitrogen fertilizer application were reported that, the nitrogen usage showed significant effect on amount of CGR, NAR, dry leaf yield, nitrogen percentage and income per hectare. According to obtained results from current study the highest amount of CGR with  $7.5 \text{ gm}^{-2}\text{d}^{-1}$ , dry leaf yield with 2690 kg/ha, total nitrogen per leaf with 3.7% and income per hectare with 15.37 million rials (nearly each US dollar = 3000 rials) were recorded from 180 kg nitrogen/ha application. On the other hand the maximum NAR obtained from 120 kg nitrogen/ha with  $34.9 \text{ gm}^{-2}\text{week}^{-1}$  [12].

One of the other important macronutrients required by the plants for optimum growth and yield is potassium. Potassium plays a critical role in different physiological and biochemical process in plant. It plays a major role in protein synthesis, ion absorption and transport, photosynthesis and respiration [6]. Potassium concentration in tobacco leaves ranges from 2 to 8 percent, which sometimes reaches 10 percent. Virginia tobacco absorbed potassium in the first three weeks after transplantation (3 percent), four weeks later (69 percent) and in the last two weeks (28 percent) will be absorbed [13]. Vaziri *et al.*, (2010) with investigation effects of plant density and different fertilizer rates on the agronomic characteristics and yield of tobacco (var. K326) were reported that, usage of potassium sulfate only had significant effect on leaf length of tobacco and on other studied traits consists of leaf width, number of leaves per plant, plant height, stem diameter, dry leaf yield and pure income was non significant. Based on obtained results from this current experiment the highest leaf length with 60.2 cm was found from 400 kg potassium sulfate/ha application [19].

Haghighi *et al.*, (2011) with study application of nitrogen and potassium on tobacco yield and yield components were found that, effect of nitrogen levels on total leaf, leaf length, leaf width, green leaf yield, cured leaf yield, end of flowering and income were significant at 1% probability level, also on height, start of flowering and nicotine percentage were significant at 5% probability level. Results show that addition of nitrogen levels up to 250 kg/ha increased height, total leaf, leaf length, leaf width, green leaf yield, cured leaf yield, start of flowering, end of flowering and nicotine percentage. Also, the highest income was related to 150 kg/ha nitrogen fertilizer. There were significant differences among potassium fertilizer levels on income and sugar percentage. Addition of potassium fertilizer levels, up to 350 kg/ha increased income and sugar percentage. In current study interaction effect of nitrogen and potassium was non significant [9]. Farrokh *et al.*, (2011) with investigation effect of nitrogen and potassium fertilizers on the wet and dry weights of flue cured tobacco components, cultivar coker 347 were reported that the effect of nitrogen application on dry leaf yield, wet stalk weight, total dry weight (shrub) and total wet weight (shrub) were significant. Also, the effect of potassium on dry leaf yield and green leaf yield were significant. In the other hand in current experiment, the combined effect of nitrogen and potassium on total dry weight (shrub) was significant. Between nitrogen levels (35, 45, 55 and 65 kg/ha) the highest dry leaf yield with 2022.3 kg/ha was obtained from 55 kg nitrogen/ha. Among potassium treatments (150 and 200 kg/ha) the maximum amount of dry leaf yield was found from 200 kg potassium/ha with average of 1896.67 kg/ha. On the other hand, between interaction levels the highest dry leaf yield with 2194 kg/ha was recorded from interaction treatment of 65 kg nitrogen/ha and 200 kg potassium/ha [4]. Farrokh *et al.*, (2012) with study effect of nitrogen and potassium fertilizer application on yield, quality and some quantitative parameters of flue-cured tobacco cv. K326 were reported that, nitrogen application had a significant effect on dry leaf yield, fresh leaf yield, stalk diameter, leaf length, leaf width, stalk dry weight, biomass and sugar percentage. But, effect of potassium fertilizer usage only was significant on sugar percentage [5].

The current study aim was to investigate the influence of different nitrogen and potassium fertilizers application amounts on quantitative and qualitative characteristics of tobacco (male sterility variety PVH<sub>19</sub>) in Talesh region (Iran).

## MATERIALS AND METHODS

In order to examine the effects of different nitrogen and potassium fertilizers application amounts on quantitative and qualitative characteristics of tobacco (male sterility variety PVH<sub>19</sub>) an experiment in factorial format with two factors based on randomized complete block design with 3 replications under field conditions in the Dyrakary Mahale Jvkandan Village (Talesh Township in Guilan Province) located in 49° 36' E longitude and 37° 16' N latitude in 2011 farming year was conducted. Region height from sea level is -7 m. the location of study area was showed in (Figure 1). Soil analysis results show that (Table 1), the soil texture was loamy clay and pH 6.8. Factors of experiment were consisting of nitrogen fertilizer with three levels (N<sub>1</sub>: 0 (control), N<sub>2</sub>: 34.5 and N<sub>3</sub>: 69 kg pure

nitrogen/ha from source of ammonium nitrate respectively 0, 100 and 200 kg/ha application) and potassium fertilizer with four levels ( $K_1$ : 0 (control),  $K_2$ : 75,  $K_3$ : 150 and  $K_4$ : 225 kg potassium oxide /ha from source of potassium sulfate respectively 0, 150, 300 and 450 kg/ha application).

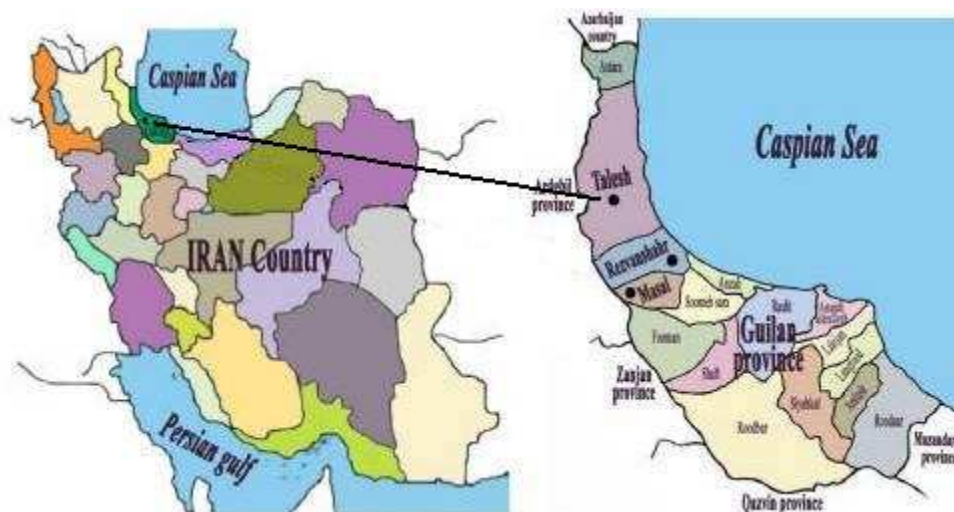


Fig 1- The geographical location of study area

Table 1- Soil physical and chemical characteristics

Soil characteristics	Amount
Depth (cm)	0-30
pH	6.8
EC (ds/m)	1.9
Organic carbone (%)	1.51
CEC (Cmol+/kg)	34
TNV (%)	9.5
Total nitrogen (%)	0.13
P (ppm)	30.4
K (ppm)	149
Ca (meq/L)	20
Mg (meq/L)	1.2
Na (meq/L)	7.49
Cl (meq/L)	0.8
Sand (%)	38
Silt (%)	26
Clay (%)	36
Soil texture	Loamy clay

Sowing in nursery was done In March 2010 and transplanted to field May 2011. After plowing and disking and leveling by rotary, tobacco seedling were transplanted in main field. In current study the space between rows was 100 cm and between plants on rows was 50 cm. The area of every plot was  $5 \times 4 = 20 \text{ m}^2$ . For weeds management in this experiment at the beginning and before transplanting of seedlings, spraying soil by herbicides (Eradicane and Sonalan) was done and in others stages controlled by hand and mechanically was performed.

To control pests and disease in experimental plots, spraying with Ridomil, Permethrine and Imidacloprid from a week after transplanting was done and also, was repeated twice in plant growth cycle at rapid growth and flowering stages. For irrigation tobacco plants, the furrow irrigation method was selected and done in five innings. Some of the work stages has been shown in (Figure 2,3,4,5)



**Fig 2- Preparing the experimental plots**



**Fig 3- Segmentation and applying fertilizer treatments to experimental plots**

Measured traits were included leaf length, leaf width, number of leaves, stem diameter, plant height, leaf area index, fresh leaves yield, dry leaves yield, the average price, gross income, leaf chlorophyll content, nicotine content on priming leaf, nicotine content on cutter leaf, nicotine content on tip leaf, sugar content on priming leaf, sugar content on cutter leaf, sugar content on tip leaf, nitrogen content on priming leaf, nitrogen content on cutter leaf, nitrogen content on tip leaf, potassium content on priming leaf, potassium content on cutter leaf, potassium content on tip leaf. Iranian rial was considered as a monetary unit for calculating of average price and gross income. Each US dollar nearly is about 3000 Iranian rials.

The data were analyzed by using MSTAT-C software. Also, the figures were draw by Excel 2003 software. The Duncan's multiple range tests was used to compare the means at 5% of significant.



Fig 4- Floating nursery of tobacco



Fig 5- Transplanting to the experimental plots

## RESULTS AND DISCUSSION

### Effect of nitrogen fertilizer on quantitative characteristics of tobacco

With attention to results of variance analysis (Table 2), the effect of nitrogen fertilizer application on leaf length, leaf width, number of leaves per plant, stem diameter, plant height, leaf area index, leaf chlorophyll content, fresh leaf yield, dry leaf yield and gross income showed significant differences at 1% probability level. On the other hand, the effect of nitrogen fertilizer usage on trait of average income was non significant.

Comparison of mean between nitrogen fertilizer application levels showed that, the highest amount of leaf length with 71 cm, leaf width with 33.2 cm, number of leaves per plant with 34.3 leaves, stem diameter with 31.2 mm,

plant height with 203.2 cm, leaf area index with 31.16, leaf chlorophyll content with 23.57, fresh leaf yield with 26447 kg/ha, dry leaf yield with 4501 kg/ha and gross income with 137.540 rials were obtained by application of 69 kg nitrogen/ha. On the other hand the lowest amount of leaf length, leaf width, number of leaves per plant, stem diameter, plant height, leaf area index, leaf chlorophyll content, fresh leaf yield, dry leaf yield and gross income respectively with 59.4 cm, 26.1 cm, 31.8 leaves, 29.20 mm, 193.3 cm, 9.86, 12.58, 17721 kg/ha, 3172 kg/ha 91.233 rials were recorded from control (without nitrogen fertilizer application) treatment (Figures 6,7,8,9,10,11,12,13,14,15).

Nitrogen in tobacco cultivation from seedling stage to harvest considered as a key element that can affect the quantity more than any other nutrients [16]. With regards to obtain results from experiment, increasing in nitrogen fertilizer amount positively increased studied traits of tobacco. Castelli *et al.*, (1990) concluded that increasing the amount of nitrogen increases the number of leaves, plant height, stem diameter and wet leaf weight [8]. Rachman *et al.*, (1990) reported that application of nitrogen increases leaf dimensions (length and width of leaf) that is causing the yield rise [7]. Mahdavi *et al.*, (2008) concluded that increasing nitrogen levels from 17 kg to 52 kg per hectare, increasing the length and width of leaves, green leaf yield and cured leaf yield [1]. These results are consistent with the findings of some researchers [9, 12, 14, 15, 21]

#### **Effect of potassium fertilizer on quantitative characteristics of tobacco**

Data presented in Table 2 showed that, the influence of potassium fertilizer application on leaf length, leaf width, leaf area index, fresh leaf yield, dry leaf yield, average income and gross income had significant effect at 1% probability level. But, the potassium fertilizer on traits of stem diameter, plant height, number of leaves per plant and leaf chlorophyll content was non significant.

Comparison of mean between potassium fertilizer application levels showed that, the maximum amount of leaf length with 68.4 cm, leaf width with 33.5, leaf area index with 15.13, fresh leaf yield with 23833 kg/ha, dry leaf yield with 4238 kg/ha, average income with 30660 rials and gross income with 131.252 rials were found from application of 225 kg potassium/ha. On the other hand, the minimum amount of leaf length, leaf width, leaf area index, fresh leaf yield, dry leaf yield, average income and gross income respectively with 60 cm, 26.2 cm, 10.33, 21107 kg/ha, 3504 kg/ha, 27528 rials and 96.68 rials were obtained from control (without potassium fertilizer application) treatment (Figures 16, 17, 18, 19, 20, 21, 22).

The effect of potassium on plant growth and crop production can be divided into five categories, including observational making plants resistant to diseases, producing hard and strong stems and reduced lodging, increased performance and transfer of starch, sugar and fat and make the plants resistant to frost [16, 17]. The most critical time for giving potassium in the early stages of plant growth. Plants deficient in potassium have less resistance against external factors but sufficient potassium, causing resistance to temporary drought, regulation of enzyme activity, increasing the intensity of photosynthesis speed up the transfer of materials made during the process of photosynthesis and also, it plays a positive role on transfer of nitrogen and protein synthesis [9]. Some studies showed similar results with results of current study [4, 5, 9, 13, 17]

#### **Interaction effect of nitrogen and potassium fertilizer on quantitative characteristics of tobacco**

The interaction effect of nitrogen and potassium application on leaf area index and gross income showed significant differences at 1% probability level (Table 2). Also, the interaction effect of nitrogen and potassium application on traits of leaf length, leaf width, fresh leaf yield and dry leaf yield showed significant differences at 5% probability level. On the other hand, influence of interaction effect treatments on number of leaves per plant, stem diameter, plant height, leaf chlorophyll content and average income was non significant.

Obtained results showed that, the highest amount of leaf length with 77.3 cm, leaf width with 37.8 cm, fresh leaf yield with 28756 kg/ha, dry leaf yield with 4975 kg/ha and leaf area index with 20.08 were recorded from interaction level of 69 kg nitrogen/ha and 225 kg potassium /ha ( $N_{69}K_{225}$  treatment). On the other hand the lowest values of leaf length with 58.2 cm, leaf width with 25.3 cm, fresh leaf yield 17559, dry leaf yield with 2958 kg/ha and leaf area index with 9.15 were recorded from control (without application of nitrogen and potassium fertilizers) treatment. Also, the maximum amount of gross income with 156.58 rials was recorded from interaction level of 69 kg nitrogen/ha and 150 kg potassium/ha ( $N_{69}K_{150}$ ) and the minimum amount of this trait with 78.29 rials was recorded from control (without application of nitrogen and potassium fertilizers) treatment (Figures 23, 24, 25, 26, 27, 28). Similar results were reported by some researchers [4, 5, 9, 13]

**Table 2- variance analysis of studied quantitative traits**

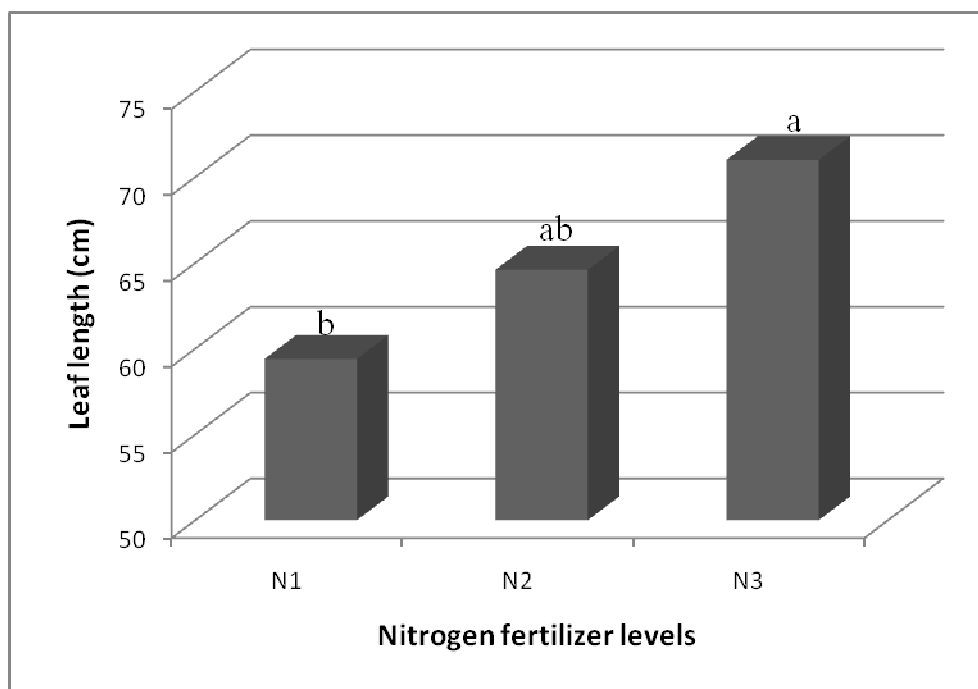
Source of variance	df	Leaf length	Leaf width	Number of leaves	Stem diameter	Plant height	Leaf area index
		Ms					
Replication	2	11.9 <sup>ns</sup>	1.3 <sup>ns</sup>	4.3 <sup>ns</sup>	2.1 <sup>ns</sup>	79.2 <sup>ns</sup>	0.7 <sup>ns</sup>
Nitrogen(N)	2	404.8 <sup>**</sup>	157.7 <sup>**</sup>	18.1 <sup>**</sup>	40.7 <sup>**</sup>	304.8 <sup>**</sup>	125.1 <sup>**</sup>
Potassium(P)	3	124.6 <sup>**</sup>	65.6 <sup>**</sup>	1.2 <sup>ns</sup>	1.7 <sup>ns</sup>	18.3 <sup>ns</sup>	38.3 <sup>**</sup>
N×P	6	24.9 <sup>*</sup>	14.1 <sup>*</sup>	0.2 <sup>ns</sup>	0.3 <sup>ns</sup>	3.2 <sup>ns</sup>	8.4 <sup>**</sup>
Error	22	9.2	5.5	3.1	0.9	48.6	1.9
Cv%		4.67	7.80	5.27	9.48	3.51	10.59

*Ns, \*\* and \* respectively: non significant, significant in 1% and 5% area*

**Continued Table 2- variance analysis of studied quantitative traits**

Source of variance	df	Fresh leaves yield	Dry leaves yield	The average price	Gross Income	Leaf chlorophyll content
		Ms				
Replication	2	4846138.9 <sup>ns</sup>	35201.1 <sup>ns</sup>	3838758.1 <sup>ns</sup>	151.5 <sup>ns</sup>	6.0 <sup>ns</sup>
Nitrogen(N)	2	248705016.8 <sup>**</sup>	5554213.0 <sup>**</sup>	6417295.9 <sup>ns</sup>	6795.9 <sup>**</sup>	361.9 <sup>**</sup>
Potassium(P)	3	14475031.6 <sup>**</sup>	984836.1 <sup>**</sup>	18445547.3 <sup>**</sup>	2020.2 <sup>**</sup>	7.4 <sup>ns</sup>
N×P	6	6987325.0 <sup>*</sup>	174674.9 <sup>*</sup>	713530.4 <sup>ns</sup>	296.9 <sup>**</sup>	2.1 <sup>ns</sup>
Error	22	2656905.7	66110.9	2364868.9	64.7	2.8
Cv%		7.14	6.56	5.21	6.84	9.19

*Ns, \*\* and \* respectively: non significant, significant in 1% and 5% area*



**Fig 6- Effect of nitrogen fertilizer application on leaf length**

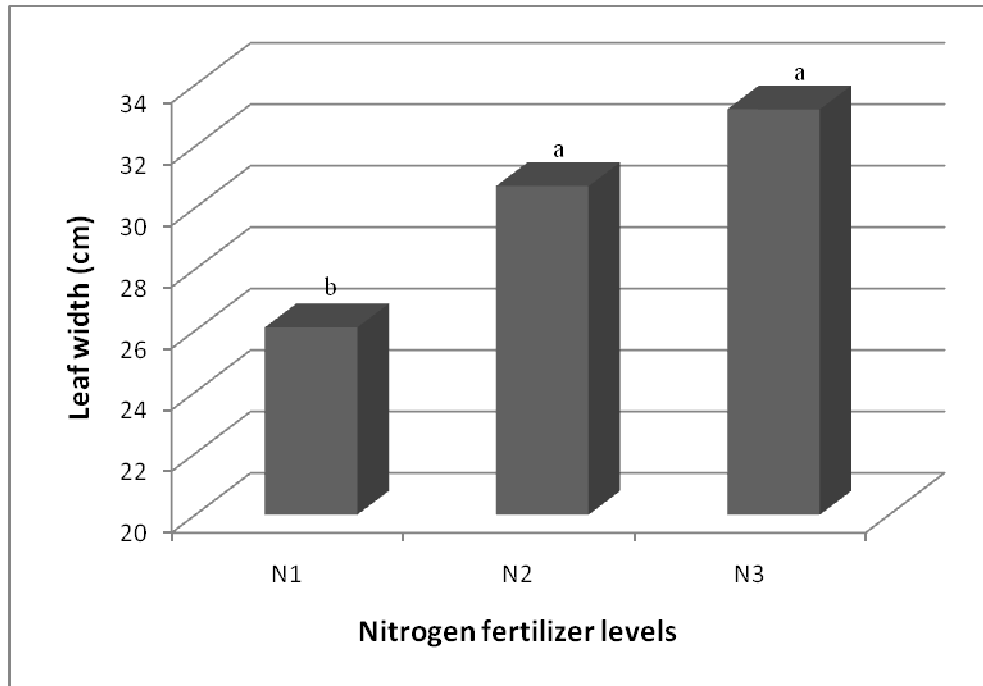


Fig 7- Effect of nitrogen fertilizer application on leaf width

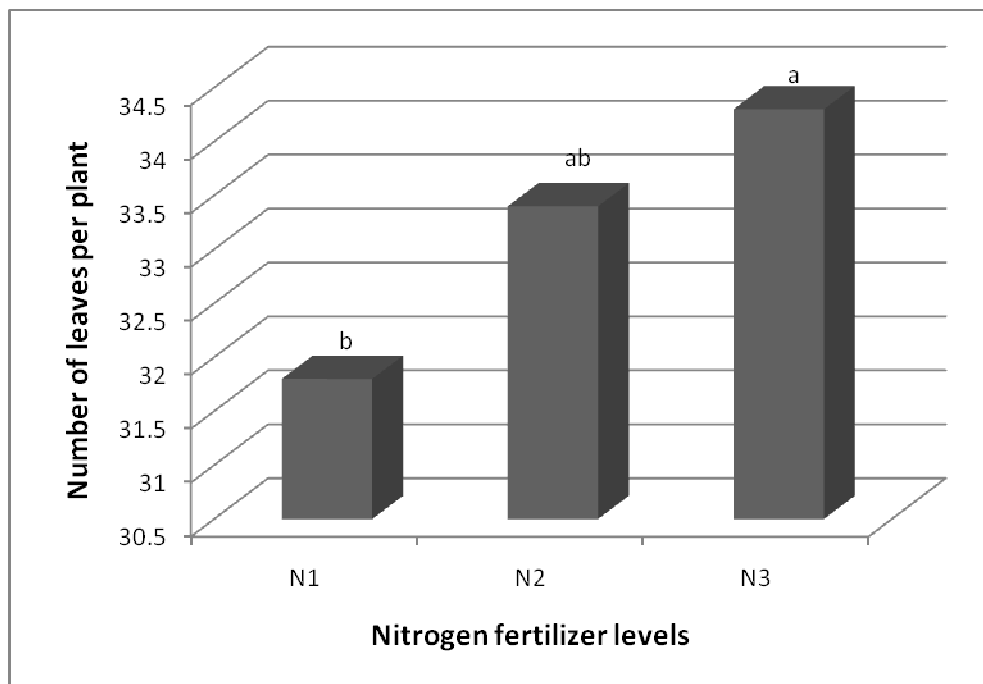


Fig 8- Effect of nitrogen fertilizer application on number of leaves per plant



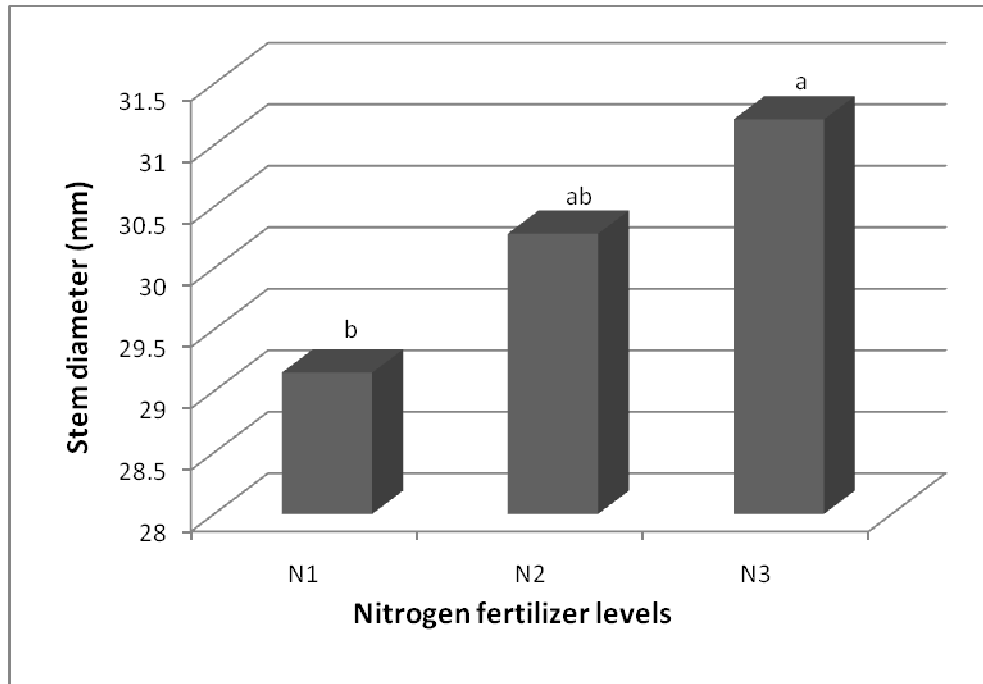


Fig 9- Effect of nitrogen fertilizer application on stem diameter

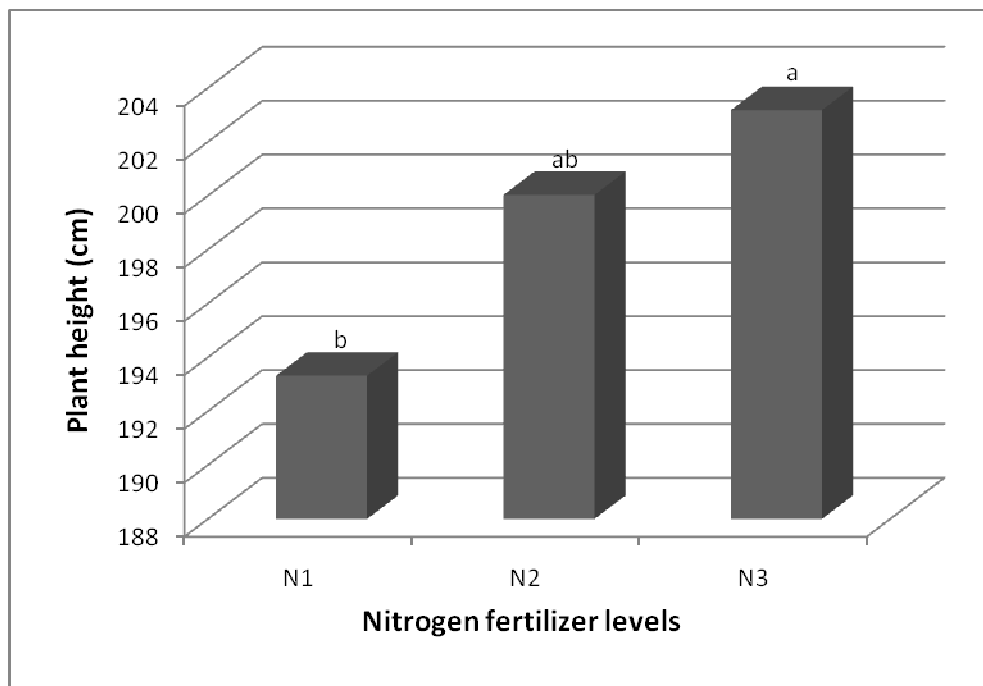


Fig 10- Effect of nitrogen fertilizer application on plant height

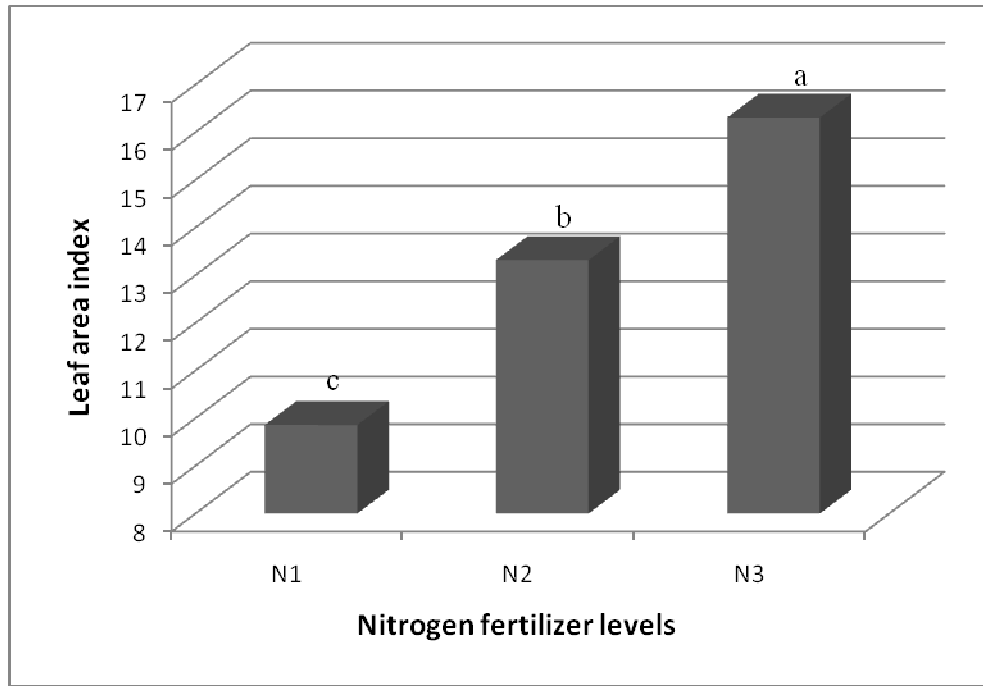


Fig 11- Effect of nitrogen fertilizer application on leaf area index

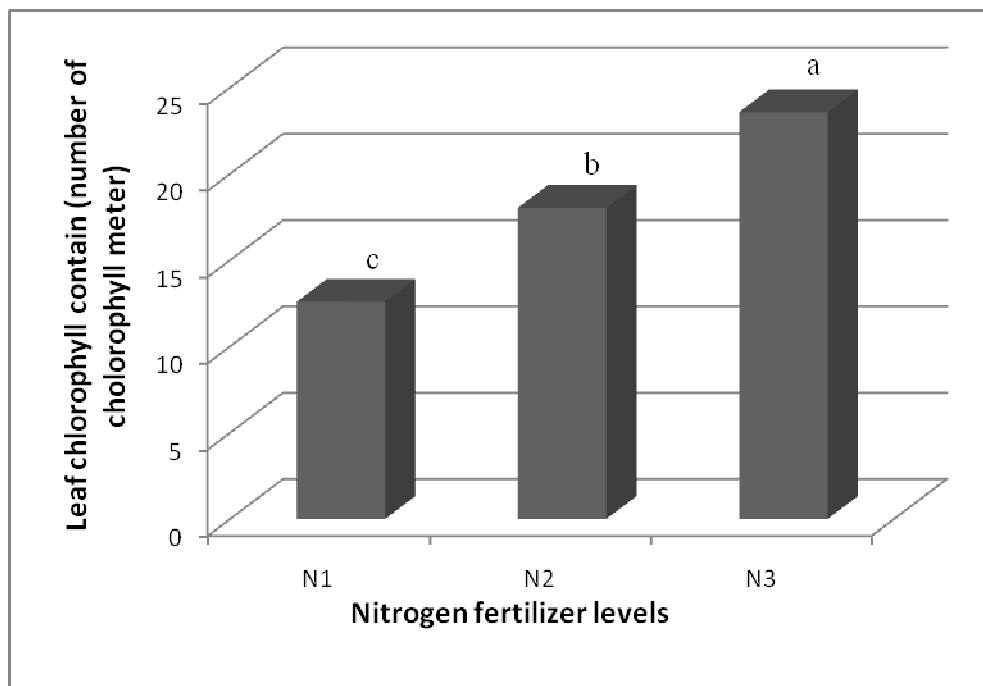


Fig 12- Effect of nitrogen fertilizer application on leaf chlorophyll

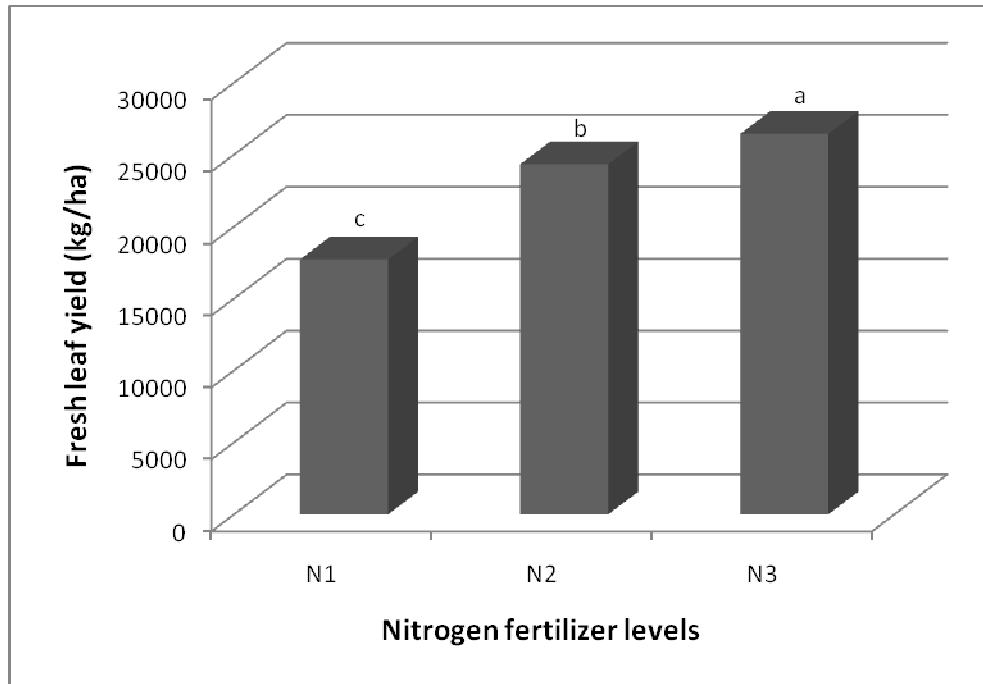


Fig 13- Effect of nitrogen fertilizer application on fresh leaf yield

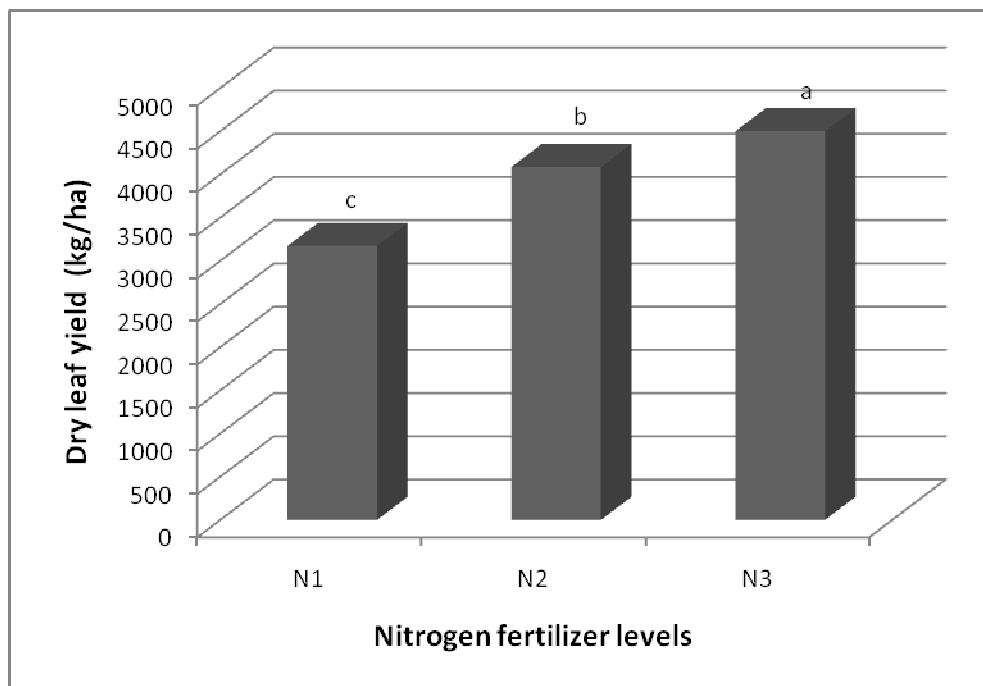


Fig 14- Effect of nitrogen fertilizer application on dry leaf yield

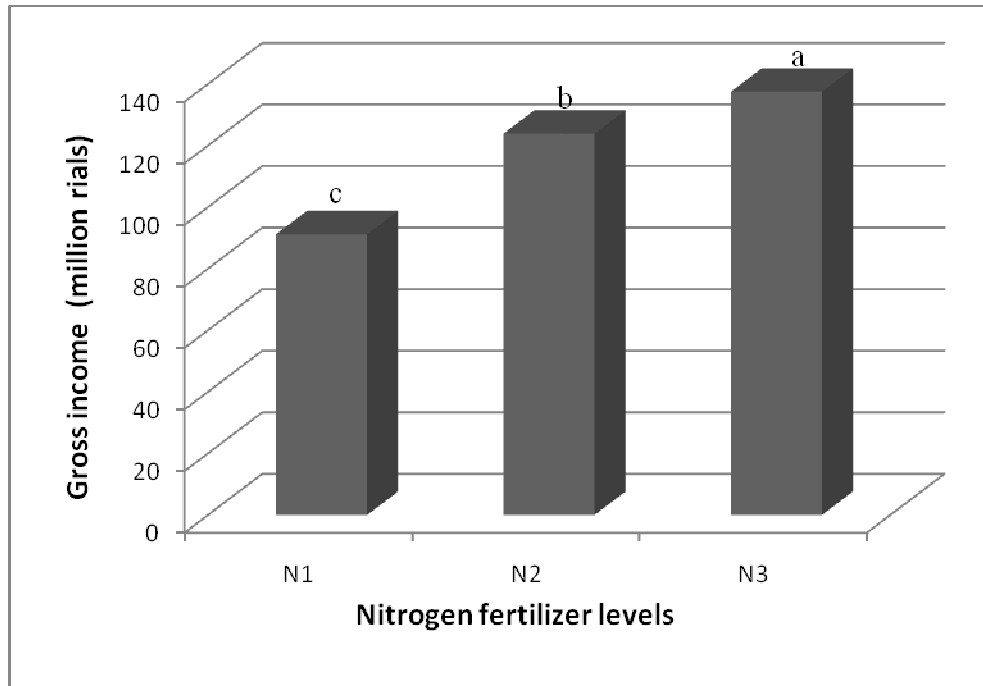


Fig 15- Effect of nitrogen fertilizer application on gross income

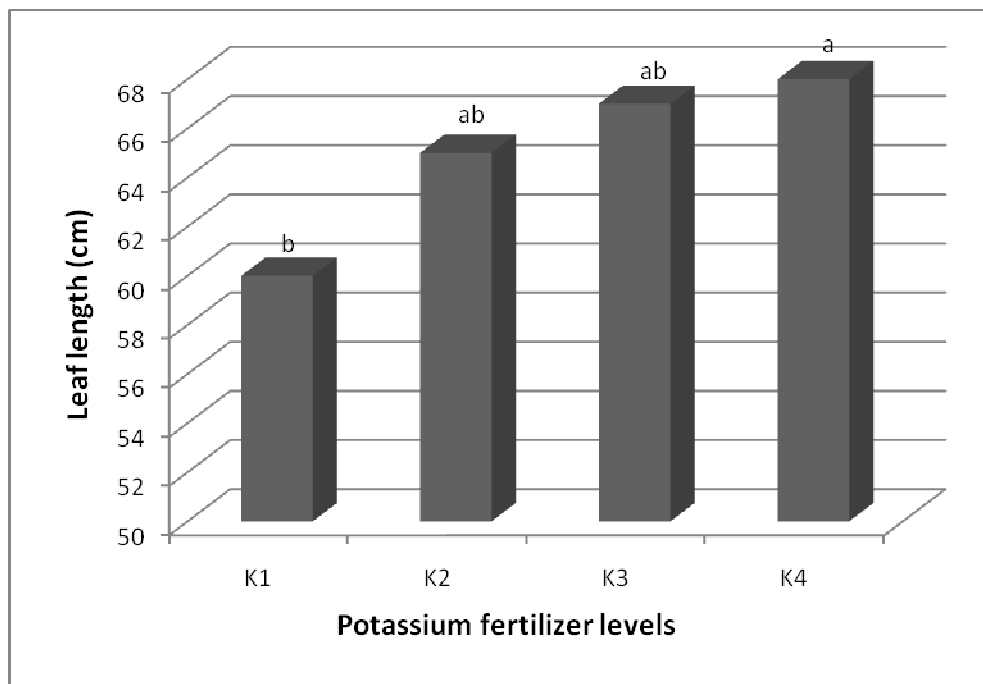


Fig 16- Effect of potassium fertilizer application on leaf length

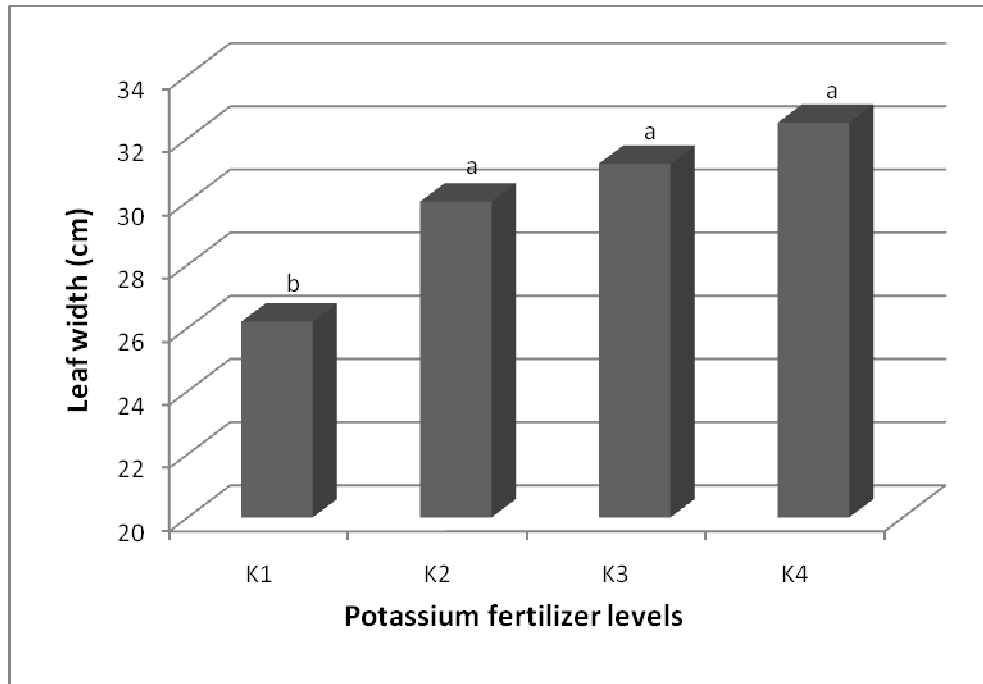


Fig 17- Effect of potassium fertilizer application on leaf width

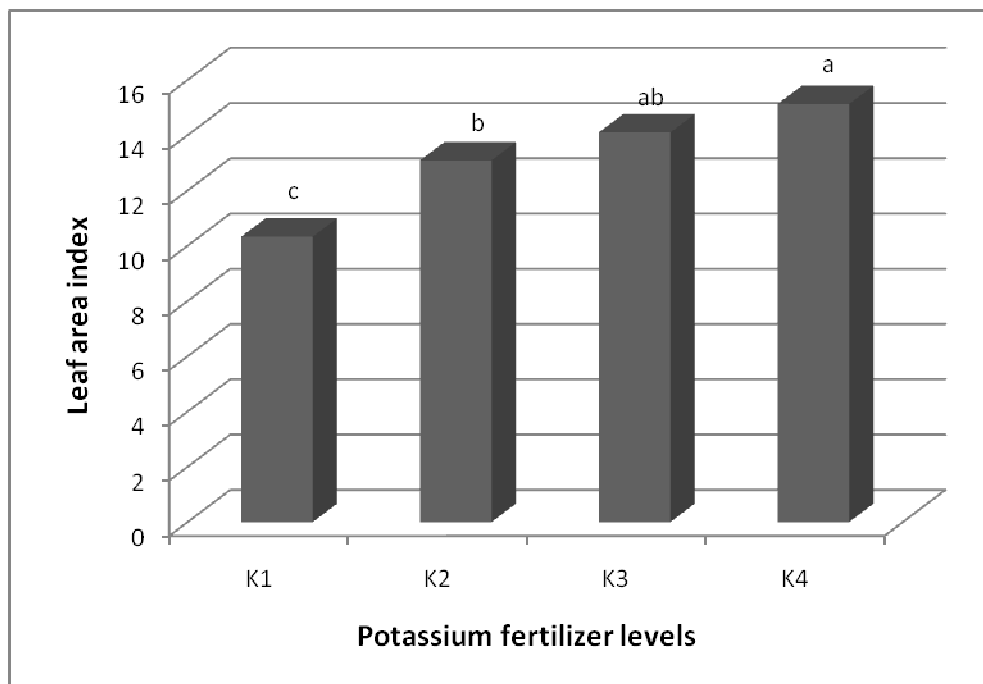


Fig 18- Effect of potassium fertilizer application on leaf area index

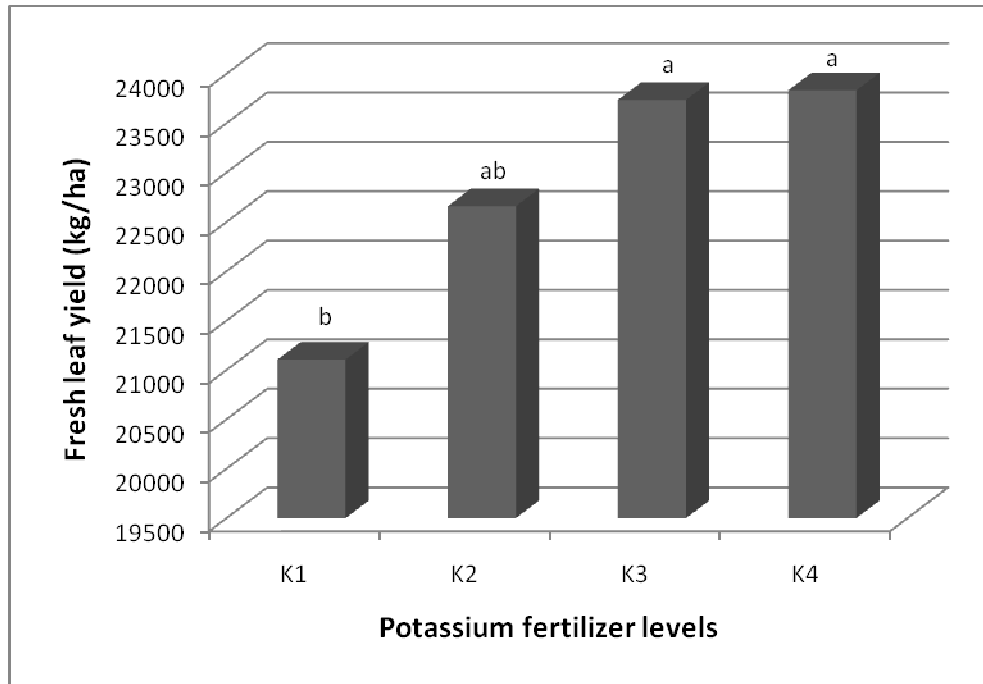


Fig 19- Effect of potassium fertilizer application on fresh leaf yield

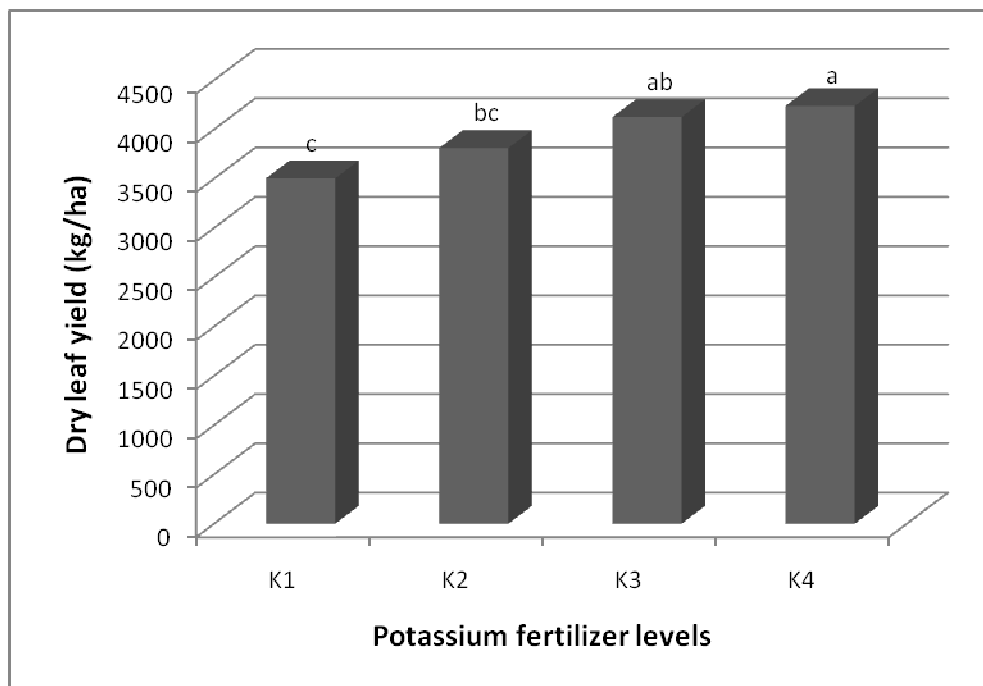


Fig 20- Effect of potassium fertilizer application on dry leaf yield

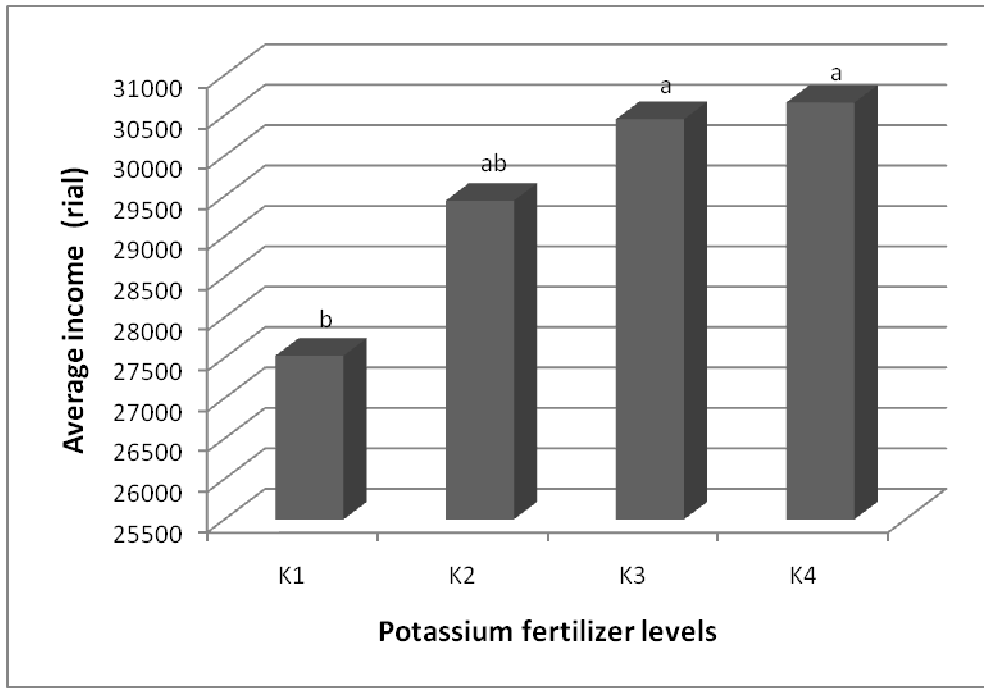


Fig 21- Effect of potassium fertilizer application on average income

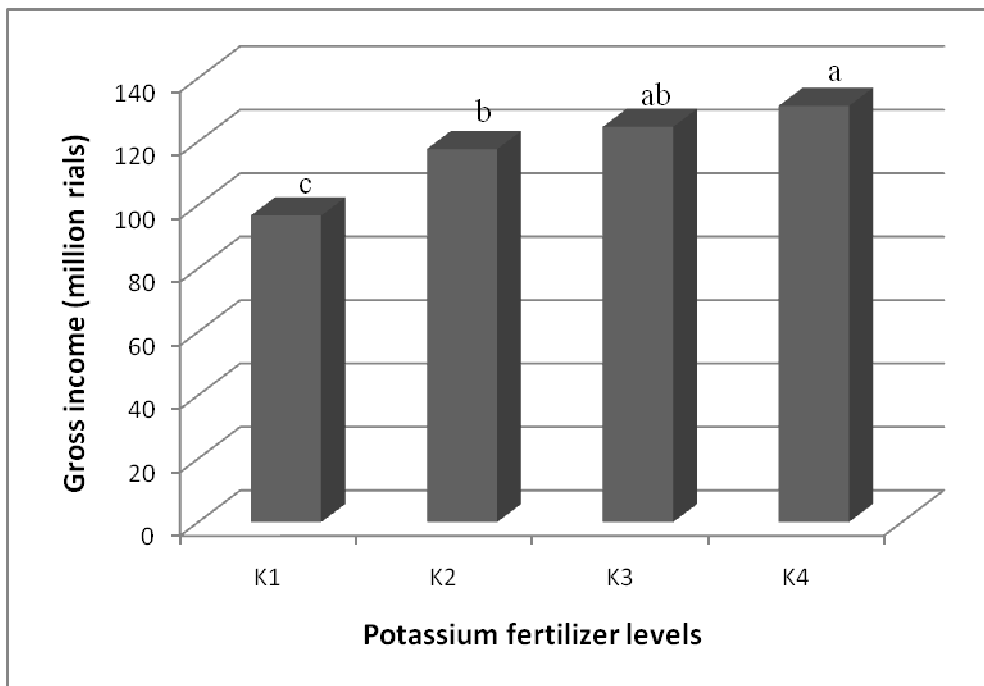


Fig 22- Effect of potassium fertilizer application on gross income

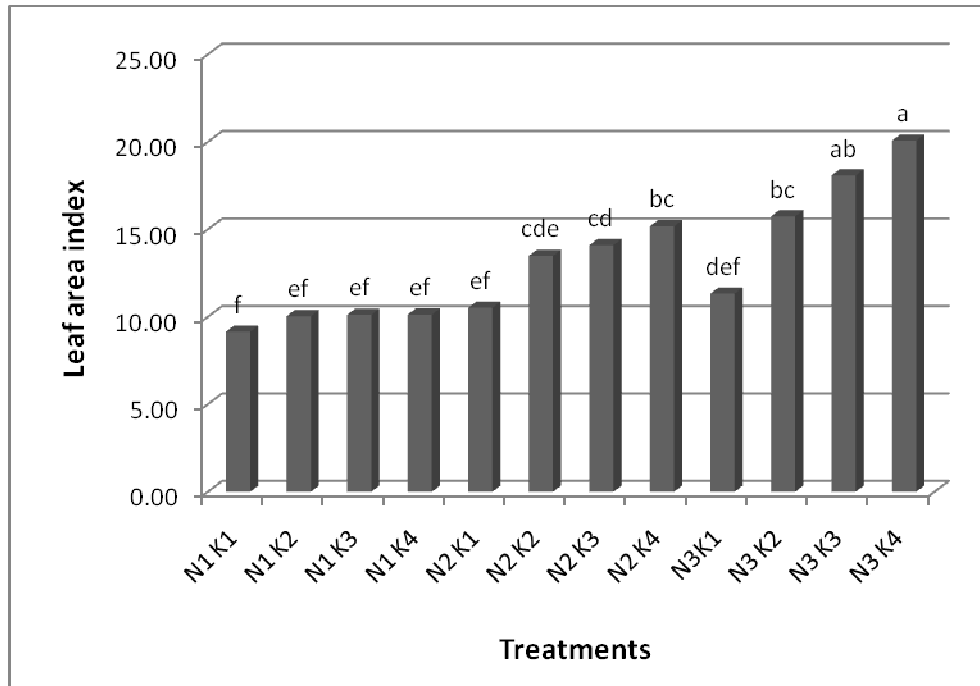


Fig 23- Interaction effect of nitrogen and potassium application on leaf area index

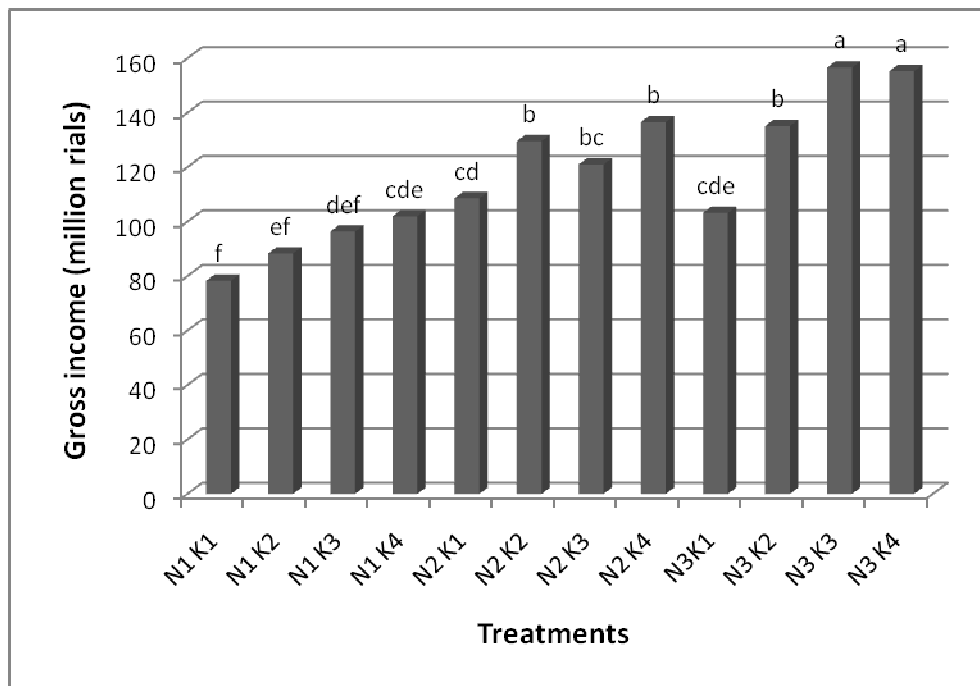


Fig 24- Interaction effect of nitrogen and potassium application on gross income



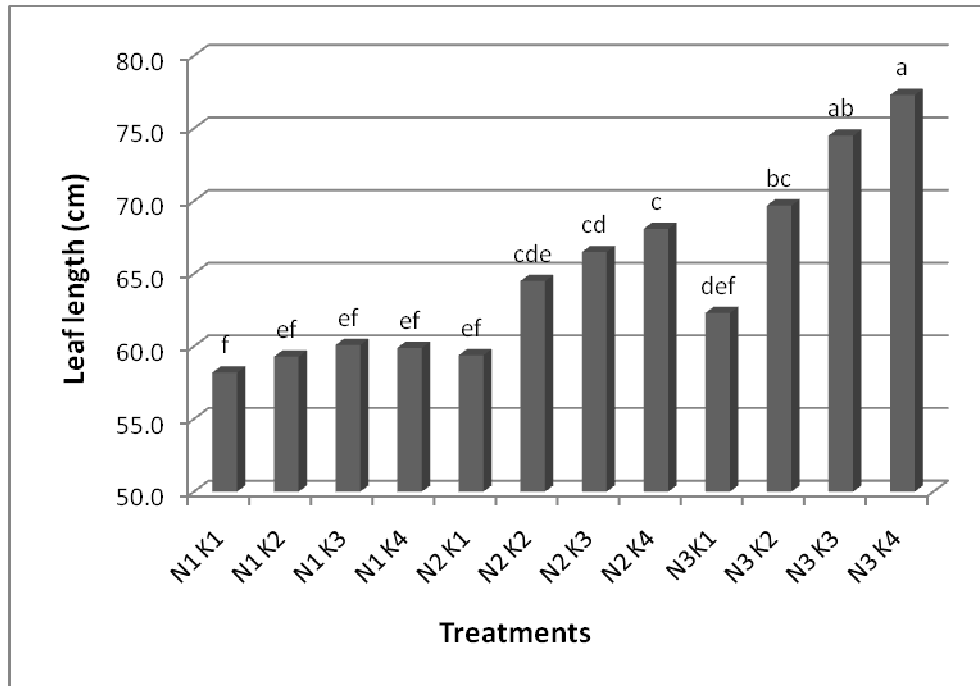


Fig 25- Interaction effect of nitrogen and potassium application on leaf length

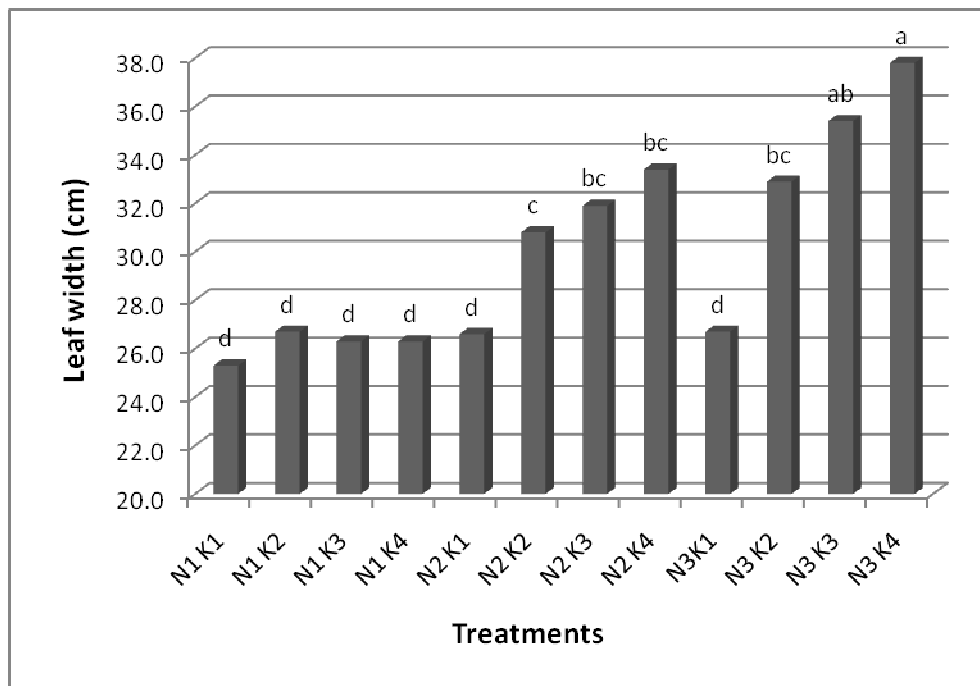


Fig 26- Interaction effect of nitrogen and potassium application on leaf width

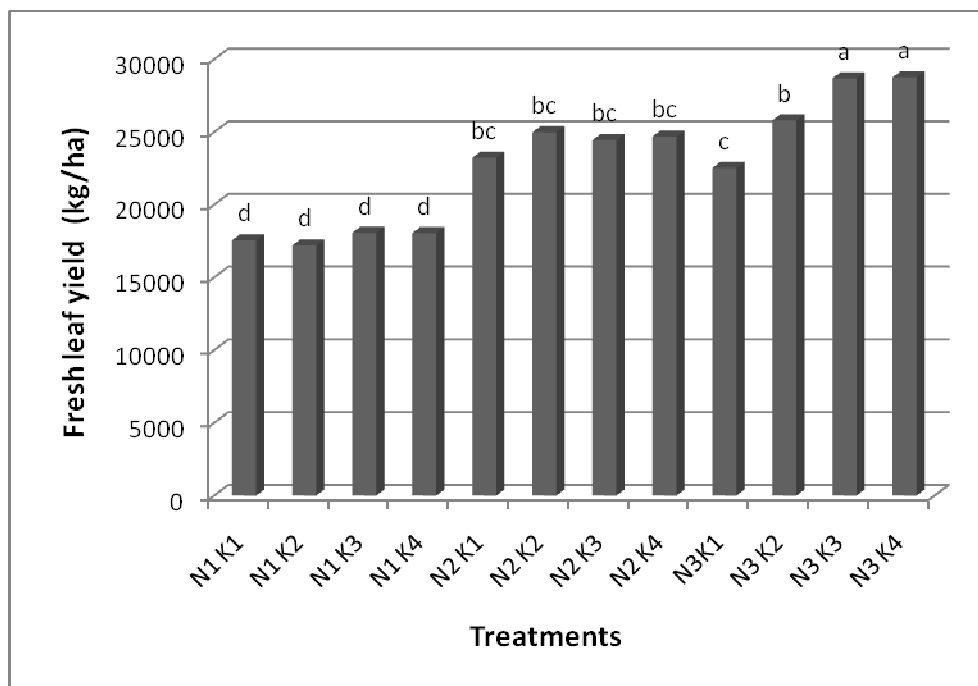


Fig 27- Interaction effect of nitrogen and potassium application on fresh leaf yield

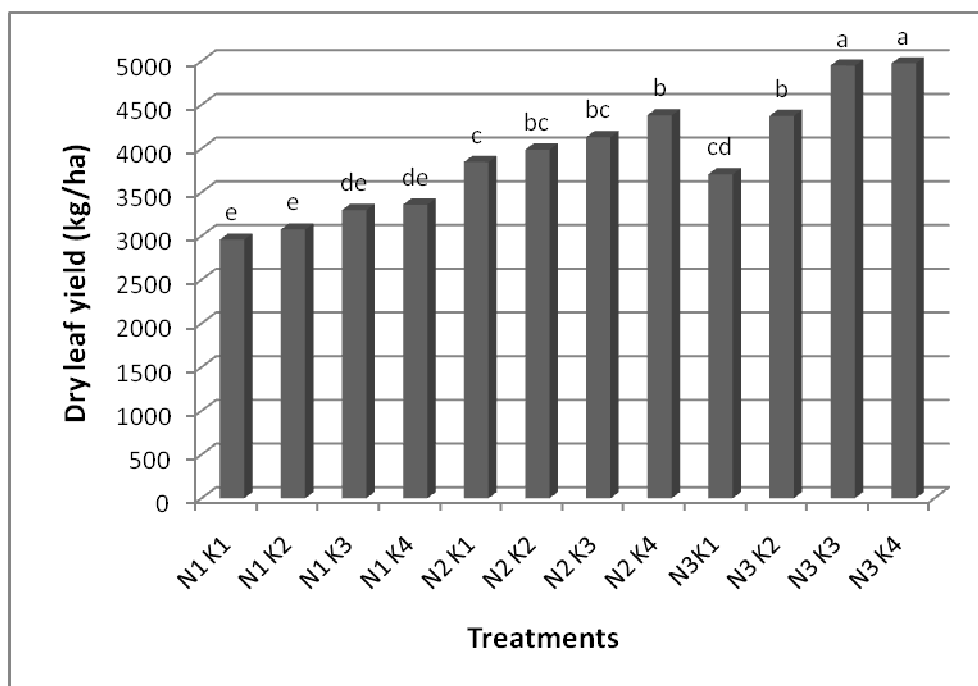


Fig 28- Interaction effect of nitrogen and potassium application on dry leaf yield

**Effect of nitrogen fertilizer on qualitative characteristics of tobacco**

The results of current study showed that, the nitrogen fertilizer application on nicotine content on priming leaf, nicotine content on cutter leaf and nicotine content on tip leaf had significant effect at 1% probability level (Table 3). Also, the effect of nitrogen fertilizer application on sugar content on priming leaf, sugar content on cutter leaf and sugar content on tip leaf was non significant.

Comparison of mean between nitrogen fertilizer application levels showed that, the highest values of nicotine content on priming leaf with 2.21%, nicotine content on cutter leaf with 3.04% and nicotine content on tip leaf with 2% were obtained from application of 69 kg nitrogen/ha. Also, the lowest amounts of nicotine content on priming

leaf, nicotine content on cutter leaf and nicotine content on tip leaf were recorded from control treatment (without nitrogen fertilizer application) respectively with 1.34%, 1.29% and 1.52% (Figures 29, 30, 31).

Nitrogen in tobacco cultivation from seedling stage to harvest considered as a key element that can affect the quality more than any other nutrients [16]. Mahdavi *et al.*, (2008) concluded that increasing nitrogen levels, increasing the nicotine but the overall effect on the ash and sugar. Nicotine is the most important in tobacco element which has alkaloid role in plant, The most and the lowest Nicotine can be found at leaf margins and leaf centre respectively [1]. Nicotine is made in root and then transmitted to the leaves [23].

Khan *et al.*, (1981) found that application of ammonium nitrate led to a better relative quality of tobacco leaf by production of plants with low amounts of nicotine and protein and high amount of carbohydrate. The lowest value of nicotine and protein was observed in the collected leaves from treatment with surface spraying method of fertilizer application. These results are consistent with the findings of some researchers [4, 5, 9, 12, 13, 17]

#### **Effect of potassium fertilizer on qualitative characteristics of tobacco**

With attention to results of variance analysis (Table 3), the effect of potassium fertilizer application on sugar content on priming leaf, sugar content on cutter leaf and sugar content on tip leaf was significant at 5% probability level. On the other hand, the effect of potassium application on nicotine content on priming leaf, nicotine content on cutter leaf and nicotine content on tip leaf was non significant.

The potassium requirement of tobacco is high and it is generally accepted that high potassium content is associated with good quality. Leaf color, texture, combustibility, and hygroscopic properties are improved by potassium fertilization [18]. Comparison of mean between potassium fertilizer application levels showed that, the maximum amount of sugar content on priming leaf with 15.02%, sugar content on cutter leaf with 13.90% and sugar content on tip leaf with 16.06% were obtained from application of 225 kg potassium/ha. On the other hand, the lowest amounts of sugar content on priming leaf with 11.55%, sugar content on cutter leaf with 11.81% and sugar content on tip leaf with 13.03% were obtained from control (without potassium fertilizer application) treatment (Figures 32, 33, 34).

Haghighi *et al.*, (2011) with study application of nitrogen and potassium on tobacco yield and yield components were found that, effect of potassium application had a significant influence on sugar percentage and addition of potassium fertilizer levels, up to 350 kg/ha increased sugar percentage [9]. These results are consistent with the findings of some researchers [12, 21, 15]

#### **Interaction effect of nitrogen and potassium fertilizer on qualitative characteristics of tobacco**

The results of current study showed that, the interaction effect of nitrogen and potassium fertilizer application on all studied qualitative traits consists of nicotine content on priming leaf, nicotine content on cutter leaf, nicotine content on tip leaf, sugar content on priming leaf, sugar content on cutter leaf and sugar content on tip leaf was non significant (Table 3).

Haghighi *et al.*, (2011) with study application of nitrogen and potassium fertilizer on tobacco yield and yield components were found that interaction effect of nitrogen and potassium on all measured traits consist of plant height, leaf number, stem diameter, leaf length, leaf width, start of flowering, flowering, fresh leaf weight, dry leaf weight, average income, nicotine percentage and sugar percentage was non significant [9]. In the other study, Farokh *et al.*, (2010) with study effects of nitrogen and potassium fertilizers on some agronomical and morphologic features of flue cured tobacco were reported that, the interaction effect of nitrogen and potassium application on traits of flowering, biomass and harvest index was significant but on dry leaf yield and stem dry weight was non significant [3].

**Table 3- variance analysis of studied qualitative traits**

Source of variance	df	Nicotine			Sugar		
		Priming	Cutter	Tip	Priming	Cutter	Tip
		Ms					
Replication	2	0.2*	0.2 <sup>ns</sup>	0.2*	0.7 <sup>ns</sup>	3.5 <sup>ns</sup>	0.01 <sup>ns</sup>
Nitrogen(N)	2	2.3**	9.2**	0.7**	13.7**	2.7 <sup>ns</sup>	1.5 <sup>ns</sup>
Potassium(P)	3	0.1 <sup>ns</sup>	0.04 <sup>ns</sup>	0.02 <sup>ns</sup>	21.5*	12.0*	16.2*
N×P	6	0.02 <sup>ns</sup>	0.08 <sup>ns</sup>	0.01 <sup>ns</sup>	0.8 <sup>ns</sup>	0.7 <sup>ns</sup>	0.3 <sup>ns</sup>
Error	22	0.1	0.2	0.04	5.4	3.7	4.0
Cv%		13.4	18.49	10.66	17.22	15.23	13.66

*Ns, \*\* and \* respectively: non significant, significant in 1% and 5% area*

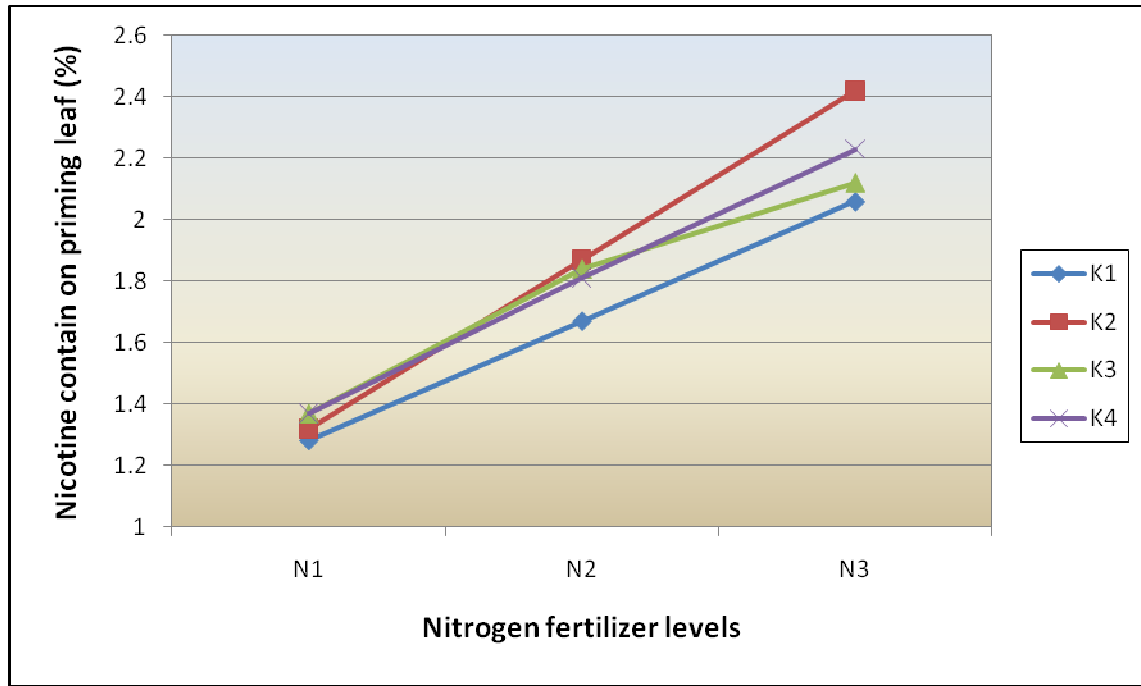


Fig 29- Trend changes of nicotine content in priming leaf

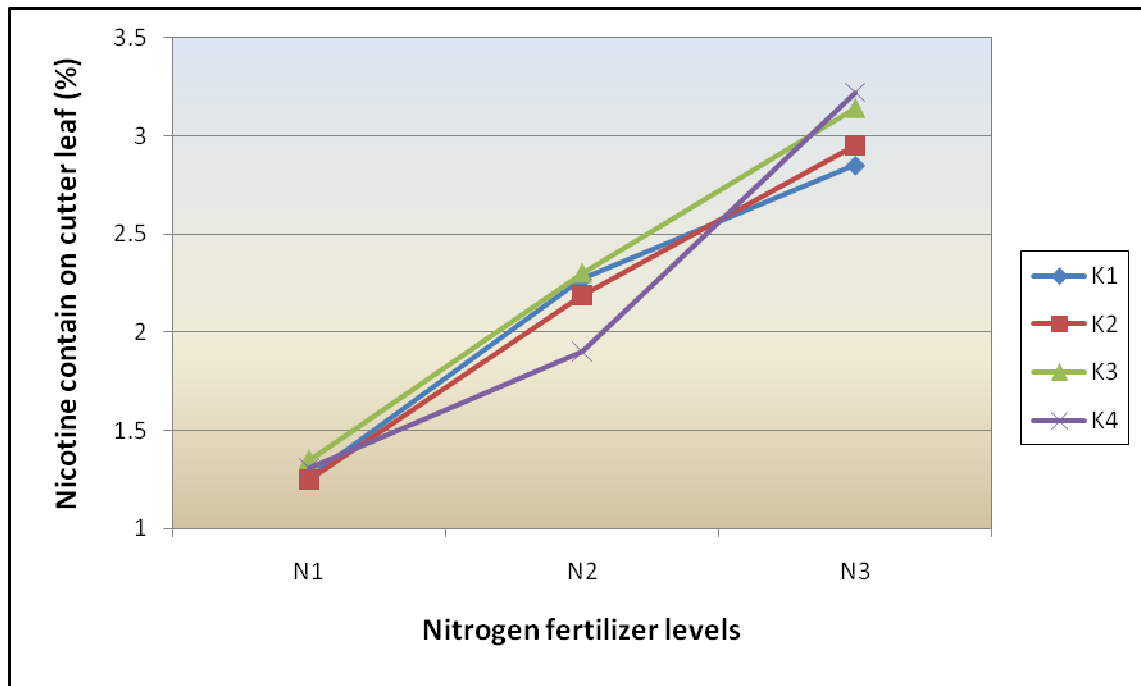


Fig 30- Trend changes of nicotine content in cutter leaf

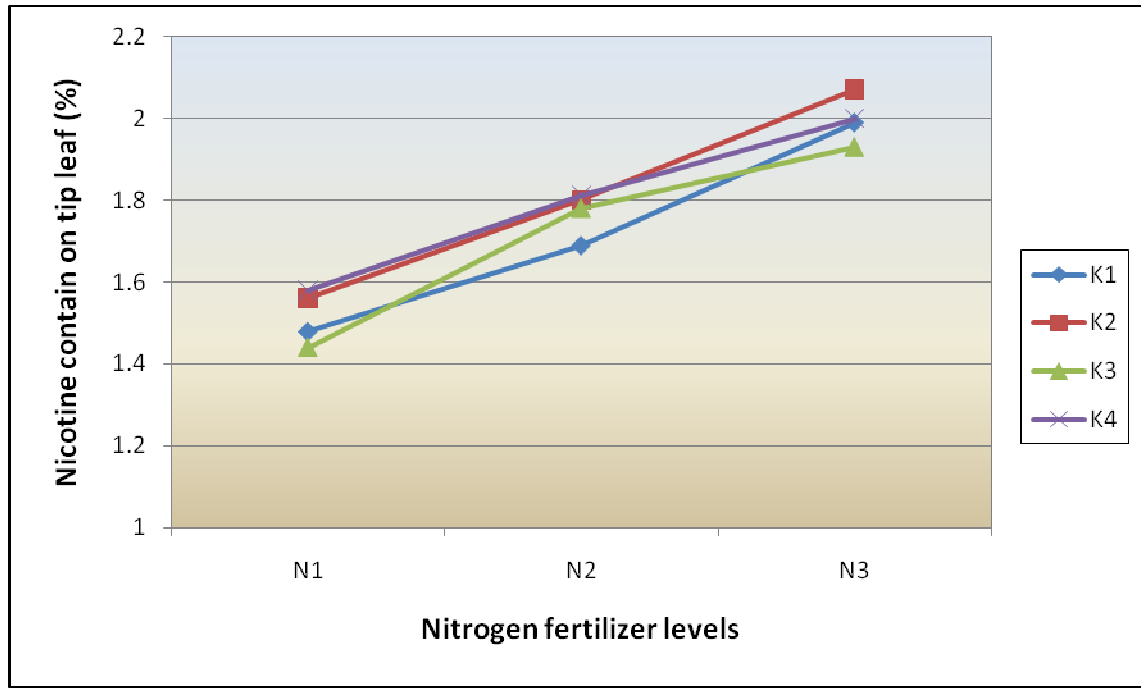


Fig 31- Trend changes of nicotine content in tip leaf

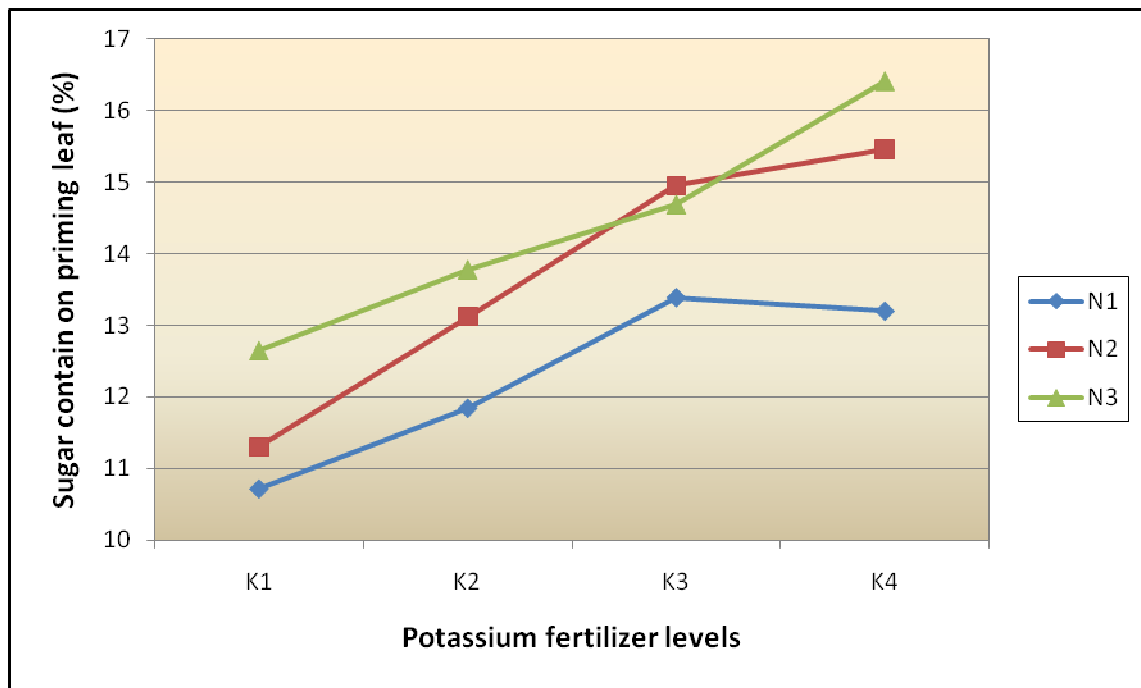


Fig 32- Trend changes of sugar content in priming leaf

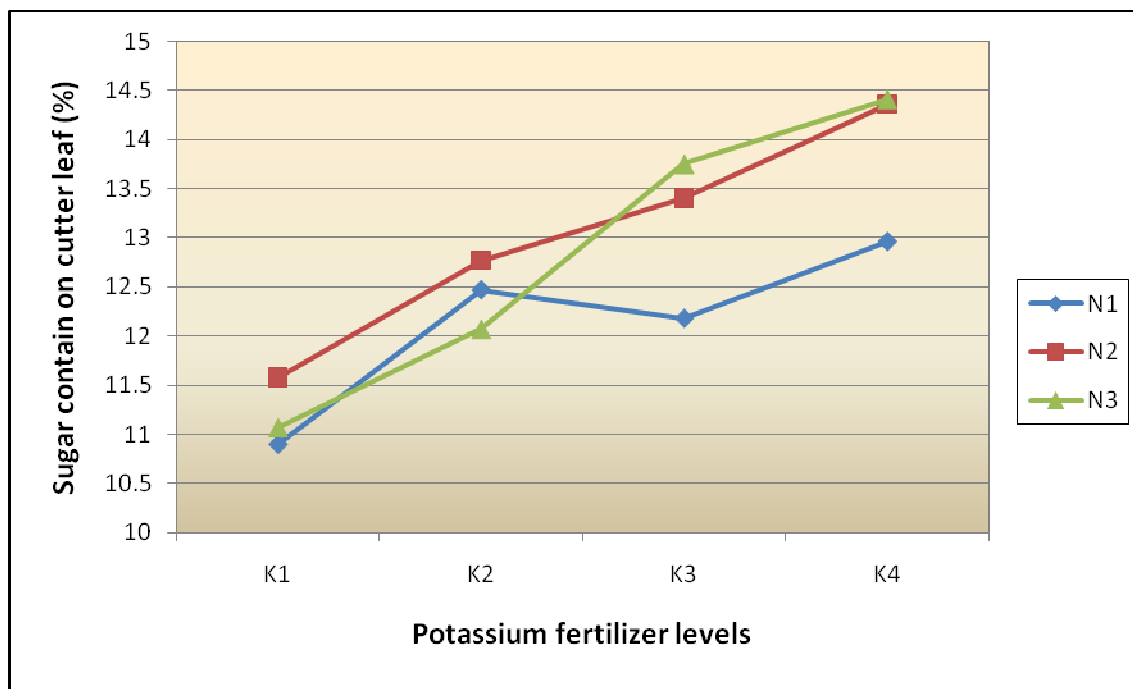


Fig 33- Trend changes of sugar content in cutter leaf

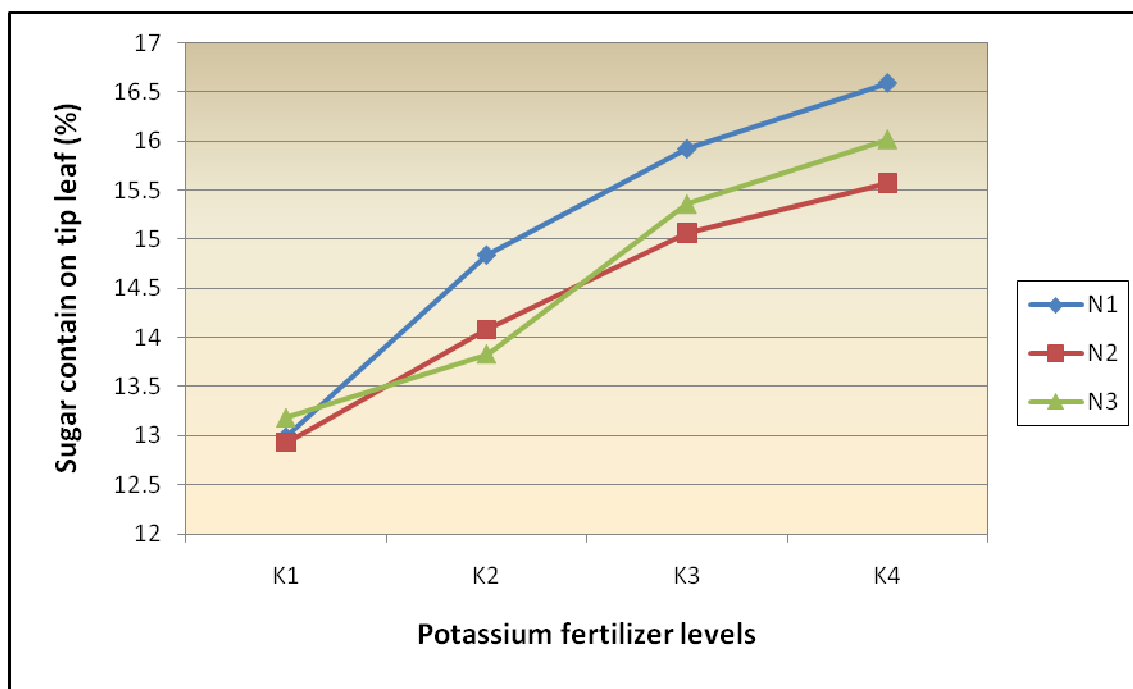


Fig 34- Trend changes of sugar content in tip leaf

**Effect of nitrogen fertilizer on nitrogen and potassium content of leaves**

Results of variance analysis showed that (Table 4), the influence of nitrogen fertilizer application on nitrogen content on priming leaf, nitrogen content on cutter leaf and nitrogen content on tip leaf had significant differences at 1% probability level. On the other hand, effect of nitrogen usage on potassium content on priming leaf, potassium content on cutter leaf and potassium content on tip leaf was non significant.

Obtained results showed that, the highest amount of nitrogen content on priming leaf with 2.04%, nitrogen content on cutter leaf with 2.37% and nitrogen content on tip leaf with 3.36% were recorded from 69 kg nitrogen/ha. On the other hand, the lowest amount of nitrogen content on priming leaf with 1.60%, nitrogen content on cutter leaf with

1.82% and nitrogen content on tip leaf with 1.64% were recorded from control (without nitrogen fertilizer application) treatment (Figures 35, 36, 37).

Mahdavi et al., (2008) concluded that increasing nitrogen levels, increasing the total nitrogen in plant [1]. Similar results were reported by some researchers [4, 5, 9, 12, 13, 17]

#### Effect of potassium fertilizer on nitrogen and potassium content of leaves

With attention to results of variance analysis (Table 4), the effect of potassium fertilizer application on potassium content on priming leaf, potassium content on cutter leaf and potassium content on tip leaf was significant at 1% probability level. On the other hand, the influence of potassium fertilizer application on nitrogen content on priming leaf, nitrogen content on cutter leaf and nitrogen content on tip leaf was non significant.

Obtained results showed that, the highest amount of potassium content on priming leaf with 2.69%, potassium content on cutter leaf with 3.87% and potassium content on tip leaf with 3.07% were obtained from 225 kg potassium/ha application. On the other hand the lowest values of potassium content on priming leaf with 1.62%, potassium content on cutter leaf with 2.13% and potassium content on tip leaf with 2.60% were obtained from control treatment (Figures 38, 39, 40).

Bozhinova (2012) was reported that, with the increase of potassium fertilization rate the content of the potassium in leaves increased from 0.65 to 4.49%. These results are consistent with the findings of some researchers [4, 5, 9, 12, 13, 17]

#### Interaction effect of nitrogen and potassium fertilizer on nitrogen and potassium content of leaves

With attention to variance analysis table (Table 4), the interaction effect of nitrogen and potassium fertilizer application on traits of nitrogen content on priming leaf, nitrogen content on cutter leaf, nitrogen content on tip leaf, potassium content on priming leaf, potassium content on cutter leaf and potassium content on tip leaf was non significant. Haghghi et al., (2011) were reported similar results with obtained results from current study [9].

Table 4- variance analysis about effect of nitrogen and potassium fertilizer on nitrogen and potassium content of leaves

Source of variance	df	Nitrogen			Potassium		
		Priming	Cutter	Tip	Priming	Cutter	Tip
		Ms					
Replication	2	0.06 <sup>ns</sup>	0.06 <sup>ns</sup>	0.26 <sup>ns</sup>	0.15 <sup>ns</sup>	0.11 <sup>ns</sup>	0.16 <sup>ns</sup>
Nitrogen(N)	2	1.49 <sup>**</sup>	0.92 <sup>**</sup>	1.57 <sup>**</sup>	0.004 <sup>ns</sup>	0.37 <sup>ns</sup>	0.02 <sup>ns</sup>
Potassium(P)	3	0.02 <sup>ns</sup>	0.04 <sup>ns</sup>	0.07 <sup>ns</sup>	2.02 <sup>**</sup>	5.64 <sup>**</sup>	3.04 <sup>**</sup>
N×P	6	0.02 <sup>ns</sup>	0.01 <sup>ns</sup>	0.01 <sup>ns</sup>	0.12 <sup>ns</sup>	0.09 <sup>ns</sup>	0.04 <sup>ns</sup>
Error	22	0.08	0.15	0.12	0.20	0.18	0.21
Cv%		14.16	18.31	17.33	20.63	13.16	17.53

Ns, \*\* and \* respectively: non significant, significant in 1% and 5% area

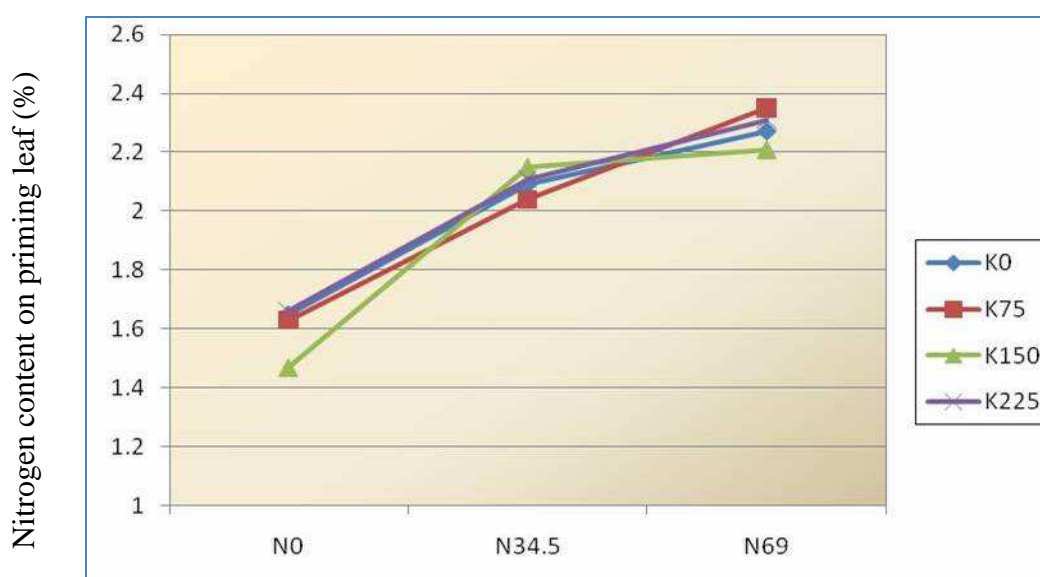


Fig 35- Trend changes of nitrogen content in priming leaf

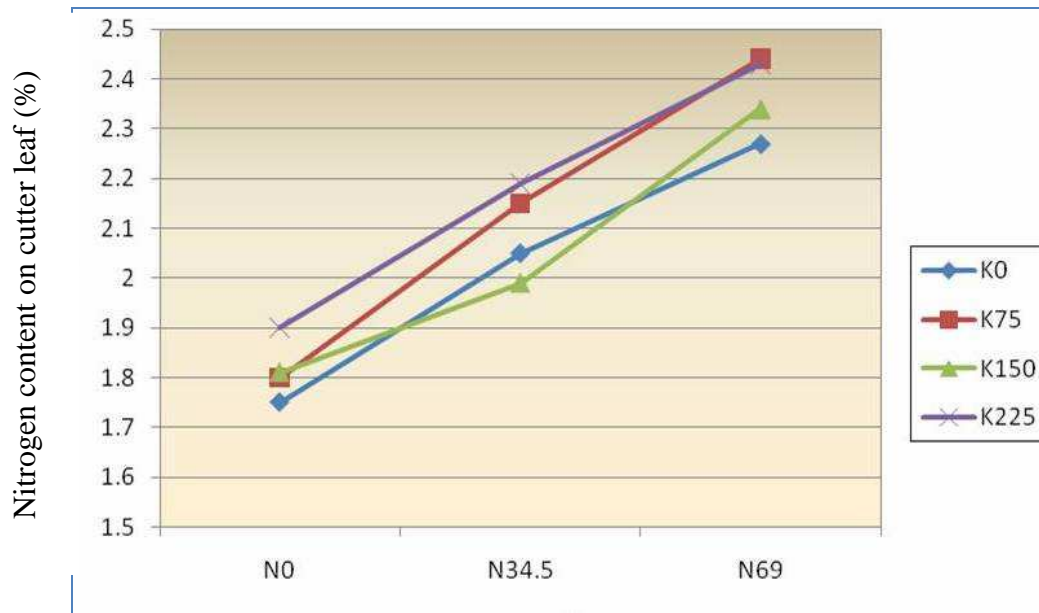


Fig 36- Trend changes of nitrogen content in cutter leaf

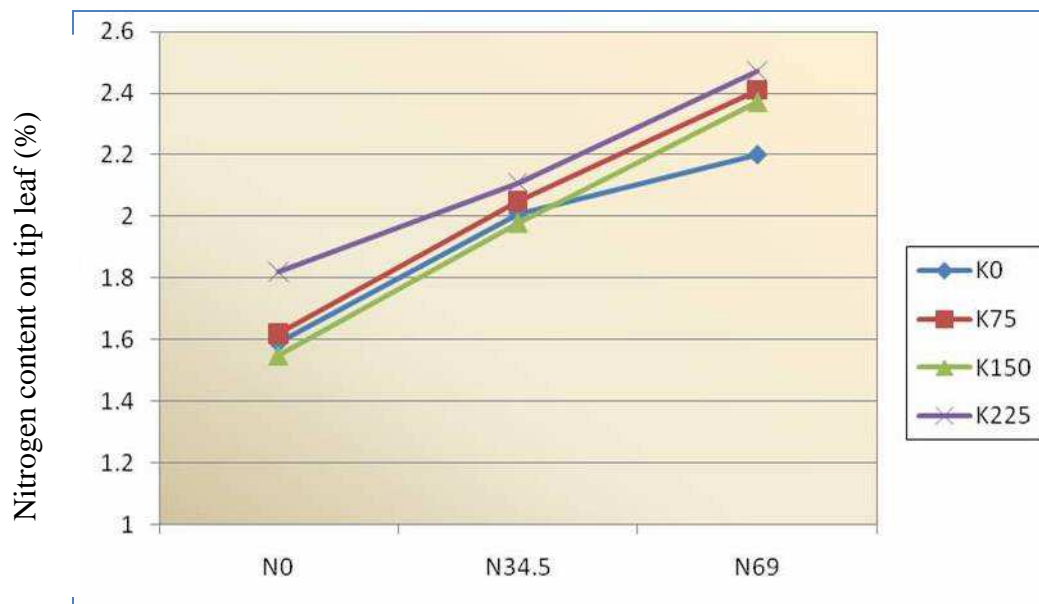


Fig 37- Trend changes of nitrogen content in tip leaf



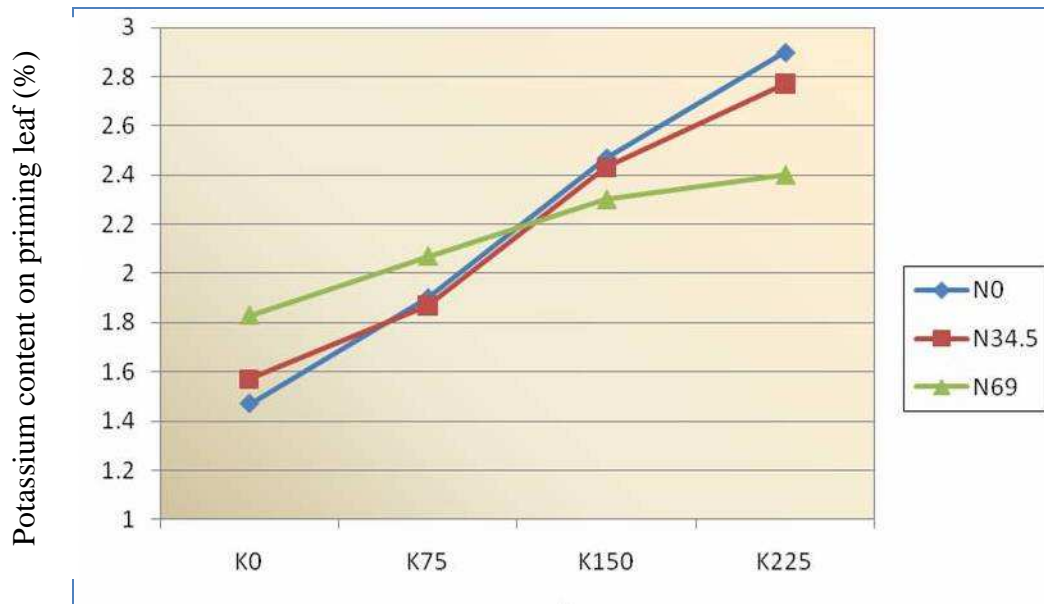


Fig 38- Trend changes of potassium content in priming leaf

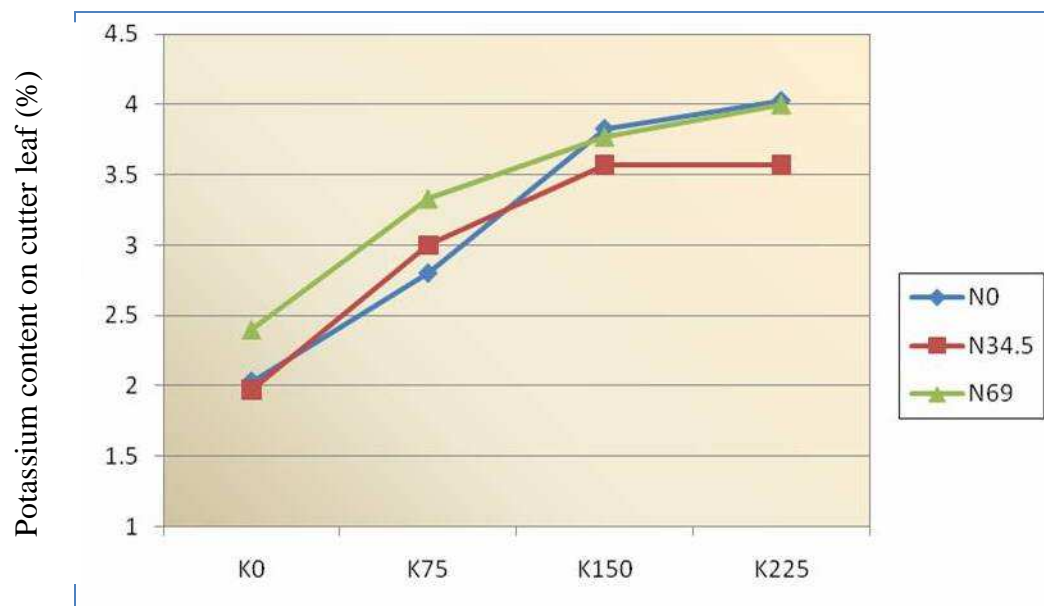


Fig 39- Trend changes of potassium content in cutter leaf

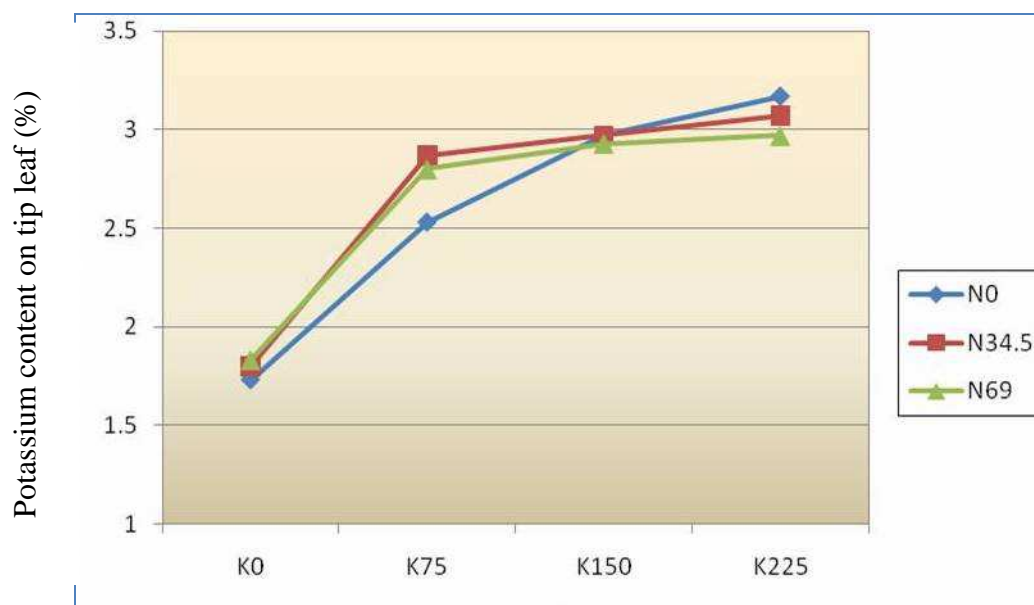


Fig 40- Trend changes of potassium content in tip leaf

### CONCLUSION

Nitrogen and potassium are two major macronutrients for achieving high yields in tobacco plants. Sufficient availability of nitrogen and potassium increase both aspects of yield that are quantity and quality. Tobacco is an industrial plant that beside the high quantity yield must be have a optimum quality yield for better sale. With regard to obtained results from current study nitrogen and potassium fertilizer utilization improve both quantitative and qualitative characteristics in male sterile tobacco variety, PVH<sub>19</sub>. Due to better performance of 69 kg nitrogen/ha and 225 kg potassium/ha fertilizer application, these levels suggested for tobacco farming in Talesh region (north of Iran).

### REFERENCES

- [1] A Mahdavi, A Gholizadeh, *Tirtash Tobacco Research Institute Publishers, Mazandaran, Iran. 2008*, Code Number, 2-101-86.
- [2] A Modhej, A Naderi, Y Emam, A Aynehband, Gh Normohamadi, *Int. J. Plant Production*, **2008**, 2, 257-267.
- [3] AR Farokh, E Azizov, M Esfahani, M Rangbarchobeh, T Razavipour Komeleh, M Rezaei and M Kavosi, *Fifth national conference on new ideas on agriculture*. Iran, Isfahan, **2010**, 1-5.
- [4] AR Farrokhi, I Azizov, A Farrokhi, M Esfahani, M Ranjbar Choubeh, M Kavosi, *International Journal of AgriScience*, **2011**, 1(5): 275-282.
- [5] AR Farrokhi, I Azizov, A Farrokhi, M Esfahani, M Ranjbar Choubeh and M Kavosi, *African Journal of Agricultural Research*, **2012**, 7(17), 2601-2608.
- [6] AV Barker, DJ Pilbeam, *CRC Press Taylor & Francis Group*, **2007**, 662 p.
- [7] D Rachman, A Suwars, *Industrial Crops Research Journal*, **1990**, 1145-1153.
- [8] F Castelli, F Miceli, F Piro, *Agronomia*, **1990**, 24: 308-316.
- [9] H Haghighi, M Sam Daliri, HR Mobaser, AA Moosavi, *World Applied Sciences Journal*, **2011**, 15 (7): 941-946.
- [10] H Khan, MZ Qazi, M Musk, *Pak. Tob*, **1981**, 5, 29-32.
- [11] HR Bozorgi, M Pendashteh, F Tarighi, H Ziaei Doustan, AK Keshavarz, E Azarpour and M Moradi, *world applied sci. J*, **2011**, 13(5): 1209-1217.
- [12] K Postini, MT Shamel Rostami, *Iranian J. Agric. Sci*, **2000**, 2, 363-369.
- [13] MA Sabeti, A Jabbarzadeh, *Tobacco Research Institute Publishers, Rasht, Iran. 2004*, Code Number, 6-103-82.
- [14] MH Aminifard, H Aroiee, H Fatemi, A Ameri, S Karimpour, *Journal of central European agriculture*, **2010**, 4, 453-458.
- [15] MH Barzegarkhou, *Tobacco Research Institute Publishers, Rasht, Iran, 2007*, 40 -56.
- [16] MT Shamel Rostami, *Tirtash Tobacco Research Institute Publishers, Mazandaran, Iran. 1996*, Code Number, 1-101-76.
- [17] MT Shamel Rostami, *Tirtash Tobacco Research Institute Publishers, Mazandaran, Iran. 1997*, Code Number, 2-101-79.
- [18] R Bozhinova, *Journal of Central European Agriculture*, **2012**, 13(3), 510-518.

- [19] R Vaziri1, A Biabani, M Azizy, AGh Gholizadeh, AR Mahdavi, *EJCP.*, **2010**, 4, 205-215.
- [20] S Hasani, HA Pirdashti, R Mesbah, NA Babaeyan Jolodar, *Journal of sapling and seed*, **2008**, 24, 45-52.
- [21] SS Singh, P Gupta, AK Gupta, *Kalyani Publishers, New Delhi, India*, **2003**, 184-185.
- [22] T Lincoln, Z Edvardo, *Sinaur Associates, Inc. Pub, Sunderland*, **2006**, 705p.
- [23] TC Tso, *Institute of international development & education in agricultural & life sciences, USA*, **2005**, 48-67.