The Effect of Nitrogen and Potassium Fertilizer on Yield and Mineral Accumulation in Flue-Cured Tobacco

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Abstract

In order to investigate the effect of nitrogen and potassium fertilizers on yield and mineral accumulation of cv.coker347 and cv.k326 of flue-cured tobacco, 2 year experiment was carried out in tobacco research institute of Rasht located in Guilan province on factorial based with 3 replications. The applied fertilizer levels included 35(N1), 45(N2), 55(N3) and 65 (N4) Kg/ha of pure nitrogen from urea source, and potassium in two levels of 150 (K1) and 200 (K2) Kg/ha potassium from potassium Sulfate. The measured parameters in this experiment included dried leaf weight, stem nitrogen, stem potassium, stem phosphorus, leaf nitrogen, leaf phosphorus, leaf potassium, plant nitrogen, plant phosphorus, plant potassium, nitrogen harvest Index, potassium harvest Index, phosphorus harvest Index. The effect of variety on dried leaf yield, stem nitrogen and plant potassium was significant on 1% level, and the variety had also significant effect on leaf potassium, plant nitrogen and nitrogen harvest Index on 5% level. The nitrogen had significant effect on parameters such as stem nitrogen, plant nitrogen on 1%level and similarly had significant effect on stem phosphorus, stem potassium and potassium harvest Index on 5% level. The potassium had significant effect on dried leaf, stem potassium on 1% level and also on plant potassium, potassium harvest Index on 5% level. The interaction between cultivar and nitrogen was significant on parameters like dried leaf yield, stem potassium, leaf nitrogen, plan nitrogen, plan potassium, nitrogen harvest Index and potassium harvest Index on 1% level and it was significant on stem nitrogen and leaf phosphorus on 5%level. The interaction between cultivar and potassium was significant on dried leaf, stem nitrogen, stem phosphorus, leaf nitrogen, leaf potassium, potassium harvest Index and nitrogen harvest Index on 1% level. This interaction on stem potassium was also significant on 5 % level. The interaction between nitrogen and potassium was significant on stem phosphorus, leaf potassium and potassium harvest Index on 1% level. This interaction on dried leaf yield, stem phosphorus, leaf nitrogen, and plant nitrogen and plant phosphorus was also significant on 5%level. The interaction among cultivar, nitrogen and potassium on parameters like dried leaf yield and stem phosphorus was significant on 1% level and this interaction on 5% level was also significant on plant potassium, leaf potassium and potassium harvest Index on 5% level

Keywords: Nitrogen, Potassium, Yield, Mineral accumulation, Flue-Cured tobacco

1. Introduction

Tobacco is one of the important crops that has key role on economy of producer countries and the obtained income from tobacco products, forms the most part of national income of these countries. Every day, millions of people are occupied directly or indirectly in cultivation, production industry and transaction of tobacco all around the world. Furthermore, millions of people smoke cigar or cigarette eagerly several times a day regarding knowing its harmful effect on health. The people great welcome to tobacco, made it as a valuable and money maker product in countries and world economy (Kafi, 2000). One of the important aspects of plant production is plant nutrition because it influences the quality of product. The matter of plant nutrition is linked to the availability of nutrients as well as their distribution in plants. The practical feature of nutrition in plants is the proper usage of fertilizers (Hagh Parast Tanha, 1991). One the main way to increase yield includes the usage of nourishing fertilizer elements in a proper and desirable amount.

Determining of proper amount of fertilizer for increase in yield is economical for farmers. It is also desirable from the view point of ecology since excessive use of chemicals cause pollution. Nitrogen and potassium are the main fertilizer elements for increasing of crop yield. Nitrogen forms 79% of atmosphere and even more nitrogen exists in soil in a shape of organic sediment. Neither Atmosphere nitrogen nor composed nitrogen in soil organic sediments is utilizable for plant growth but oxidized and reduced form of it. Hydrogen bond which causes nitrogen reduction could be produced through thunder and lightning, nitrogen stabilizing creatures or in a commercial form by Haber-Bush processes (Shirdani, 2001; Prasad, 1995). Nitrogen is footstone of organic nitric compounds like Whiteners, vitamins, chlorophyll, enzymes and organic base (Khoda, 1994).

Potassium is found sufficiently in majority of soils and forms 2.4% of earth's crust. Soil potassium is in three shape of: 1- rather non absorptive which includes 90-98 % of total potassium. 2- slow-absorptive which include 1-10% of total potassium. 3- Quick absorptive which includes 0.1-25 of total potassium. Quick-absorptive potassium exists in soil solution and will be absorbed easily by plants (Mazaheri, 2001).

The available potassium in earth's crust is around 1% .the absorbed potassium is not comparable with required nitrogen. Potassium amount varies in different soils and annually consumption of fertilizers is necessary in some soils due to shortage of potassium. In some other soils, potassium accumulation is too high so that even after years of plant cultivation and leaching which discharge potassium from soil, there is no need using fertilizers (Shahdi, 2002). Potassium is an essential element in plant nutrition which is interfered in amino acids and proteins synthesis from ammonium (Salardinie, 1995). In a factorial based experiment on randomized complete blocks which was carried out at tobacco research institute of Rasht, the effect of nitrogen levels (0, 15, 30, 45, 60 and 75 Kg/ha) on cv.Coker347 (flue-cured tobacco) was investigated in 1381. In this experiment, different nitrogen levels to form topdressing, and the time of fertilizing were A factor, different amounts of nitrogen were B factor. Parameters related to B factor such as dried leaf yield, hectare income, leaf nitrogen, mean price and leaf chlorophyll content showed significant diference. Related to A factor, (time of topdressing fertilizing) no significant differences was detected in dried leaf yield, mean price, hectare income as well as leaf nitrogen after topdressing. But leaf chlorophyll content (before and after topdressing) and leaf nitrogen (before topdressing) had significant differences.

The maximum amount of leaf dried yield was 1909 kg/ha obtained from treatment of 45kg/ha nitrogen. The least mean price was related to treatment of 75kg/ha and the most one was related to control. The greatest chlorophyll content and nitrogen (before and after topdressing) were detected in treatment of 75kg/ha (Mohsen, 2000). Some experiments were carried out for two years in the center, east and west of Thailand in order to investigate the effect of organic and chemical fertilizer on fall and spring tobacco. The organic fertilizer was made in a company in Thailand {(30)3 (MgO) : 15 (K_2O): 10 (P_2O_5) : 5 (N) and (30) 15 (K_2O) : 15 (P_2O_5 : 5 (N)}, whereas N-P-K fertilizers were used in 9:18:17 and 7:21:21 ratios. Levels of 40, 60 and 80 kg/ha nitrogen were used in both kinds of fertilizers. The results indicated that the quality of tobacco was better in east of Thailand due to the heaviest utilization of organic fertilizer compound but no significant difference was seen in yield of fertilizer treatments. During the second year of cultivation (1995-96), the organic fertilizer compound, in level of 60 kg/ha nitrogen caused the best pure profitability for autumn tobacco in taichung area. The yield was increased for both organic and chemical fertilizer compound due to raise in nitrogen levels. Although the use of organic fertilizer led to more yield compared to chemical fertilizer with the same nitrogen level, this effect was not seen in the second year (Juang, 1996).

The effect of nitrogen and cultivation density upon eastern or Asian tobacco (oriental) cv.Erzogovina was studied In another experiment for 5 years with three levels (0, 30 and 60kg/ha) and three density (55cm×26=69 930 plant/hectar, 55cm×18=101 010 plant/hectar, 55cm×14=129 870 plant/hectar). The measured parameters were plant height, leaf number, leaf area, cultivation until blossom, leaf dried weight and technological value. All the parameters except cultivation until blossom and dried leaf weight showed variability due to nitrogen fertility during experiment years and affected positively by nitrogen (Greco, 1999). In another experiment, the effect of cultivation density on eastern or Asian tobacco (cv. Xanthiyaka) was studied for 5 years. 3 nitrogen levels (0, 30, 60 kg/ha) and three density levels of (55cm×9=202 02 plant/hectar, 55cm×11=165 289 plant/hectar, 55cm×15=121 212 plant/hectar) were utilized in this experiment. The measured parameters were plant height leaf number, cultivation until blossom, leaf dried weight and technological value. All the parameters except leaf dried weight, plant height and leaf number showed variability due to nitrogen fertility during experiment years and affected positively by nitrogen. By greater cultivation density, the leaf area became decreased and tobacco leaf dried weight was increased. By higher amount of nitrogen usage, leaf dried weigh and leaf area were increased. Moreover, 60kg/ha nitrogen and 202 020 plant density revealed interaction effects on technological values (Greco, 1999). An experiment was carried out in Indian farmer's fields of Andhra Pradesh, chitoor district, romipicherla mandal areas in order to investigate the effects of planting time, nitrogen levels and organic fertilizer on growth and yield of Asian or eastern tobacco. Based on obtained results, planting on firs 14 days of November would lead to taller plants with more leaf area, dried matter, and green leaf yield as well as dried leaf yield. Utilizing nitrogen up to 20 kg/ha recorded more value for each parameter. During first 14 days of November with providing 20 kg/ha nitrogen, parameters such as growth, green leaf yield, dried leaf yield and nicotine were increased. The sugar amount in delayed planting was decreased and had negative correlation with fertilizer requirements (Reddy, 2003). In an experiment which was done in India, the effect of 3 levels of nitrogen and three times of topping on yield and quality of tobacco (cv.6534) were investigated for 2 years. The results of analysis revealed that an average topping has significantly better yield compared to low topping or with out topping (1992kg/ha) (Giridhar, 2000).

A pot experiment was designed to study the usage and absorption of nitrogen by flue-cured tobacco and nitrogen availability of soil (AN) in deferent levels of nitrogen usage via 15N detector. The results showed that the absorbed nitrogen in all growth times was from available nitrogen in soil. By adding more nitrogen, tobacco plants absorbed more nitrogen from fertilizer and nitrogen absorption from soil was decreased. At the same time, by adding more nitrogen to soil nitrogen fixation increased and soils AN value was reduced. Although the maximum AN value was seen when 3.75 G nitrogen used in each pot (Siavash, 2002).

Vanilo et al showed that nitrogen concentration of tobacco leaf increased at the first growth stages due to more root activity (Bruns, 1988).

The results of an experiment which was performed in china for investigating the effect of macro fertilizer indicated that: 1- chemical compounds of fresh leaves of tobacco in topping stage had been affected differently by usage of fertilizers. More Nitrogen contents of leaves are shown apart from soil productivity. But available phosphor content of leaf was not influenced by added phosphor regarding soil productivity. Leaf Potassium content in plant which has grown in fertilized soils was greater rather than non fertilized soils.2- Tobacco leaf ripening slightly delayed because of applying higher level of nitrogen fertilizer especially in fertilized soils. High nitrogen cumulating in tobacco leaves in late growth stages led to poor quality index with high nicotine and low sugar contents of leaves.3- Since nitrogen usage increased regardless soil fertility, leaf nicotine content was significantly intensified but sugar content reduced. Results of another experiment of nitrogen effects on Asian or eastern tobacco revealed that nitrogen delays maturity and leaf senescence and it widens leaf size and increases leaf wet weight and micro element concentration (Drossopoulos, 1998). In another field experiment different potassium levels were applied in various times in high fertilizer coverage. According to the results, effect of different levels on yield and quality was not significant. Potassium usage after transplanting did not influence on leaf potassium content. Although usage of more than 240Kg/ha K_2O increased leaf potassium content, there was no harmony between this increase and amount of applied potassium and even it was not economic (Shamel, 2001). In order to investigate the effect nitrogen and its source or flue-cured Tobacco, some experiments were carried out, the results indicated that the suitable amount of nitrogen for northern status were 40-60Kg/ha as well as 70-90 Kg/ha for southern states. Every year, nitrogen (NO_3) had positive effect on improvement of tobacco yield and its quality and generally, nitrogen in nitrate shape produces the greatest amount of high quality tobacco. Mineral nitrogen increased the yield and crop quality rather than organic resources. On the other hand, total Alkaloids content was higher in treatments with using mineral nitrogen (Guyl, 1998). An experiment carried out in karnataka area of India to test the effect of nitrogen and potassium of flue-cured tobacco growth (1983-1987), Potassium content had more harmful effects rather than nitrogen under drought stress. Leaf yield was associated with nitrogen and potassium content positively and significantly. N/P ratio was associated with light leaf production in growth stage (Janardhan, 1989).

2. Material and Method

In order to check nitrogen and potassium effects on yield and mineral element accumulation in flue-cured, tobacco cv coker347 and cv K326, two years experiment conducted in 2008-2009 with 35(N1), 45 (N2), 55(N3), 65 (N4) Kg/ha nitrogen from urea source and 150(K1), 200 kg/ha potassium from potassium sulphate source regarding common condition of region and experts advice in factorial design in Tobacco research institute of Rasht located in Guilan province at longitude 49˚3´east and latitude 37˚ 16´ north and 25 altitude from sea level. In March of 2007-2008, the nursery of tobacco seedling was prepared. Afterward, it was disinfected using vapan (0.1lit/m^2) and covered by plastic. After 20 days the cover was removed and leveling and beating of nursery bed started at the end, fermented animal fertilizer was used in 0.5-1 cm thickness. Seeds were scattered over 0.1-0.18 m^2 of nursery. From this time until transplanting of seedlings to the main field, all operation like irrigation, covering the nursery at nights, spraying pesticides were carried out, the field of experiment kept fallow the year before sowing. Field providing activity such as fall tillage and rather deep spring tillage vertical to fall tillage were performed and 4lit/ha radical herbicide was used before sowing and mixed with soil through disking. In order to measure the physical and chemical parameters of soil, after providing of main land, a composed soil sample was taken from 0-30cm depth and dried and sieved through 2mm steal sift. After Ploughing and primary leveling by hoe, the seedlings were, transplanted in 6 lines when they were 20-50 cm high. The space between rows was 110cm and between plants on rows was 55 cm. the space between plots and replications were 1.5 and 2.5 m respectively. 50 % of determined fertilizer level for each plot was applied before sowing and transplanting. Regarding importance of plant number, new seedlings were replaced with the lost ones. Irrigation time was determined using a tansiometer based on suction power of 40-50cm bar. Weeding control and crust breaking were performed twice. In order to prevent from Agrotis damages, Ambush and noakron were used respectively 1and 4 liter per hectare.

50 % of remained fertilizer level was applied on two bands in 10 cm depth of soil. Topping in tobacco is one of the most important operations to improve plant growth, development, quantity and quality. Flowers pluse 2-3 stem final leaves were picked when 50% of plants were at flowering time. Afterwards, in order to prevent growing of lateral bud, maleik dehydrogenize contained potassium salt is sprayed. Studied parameters in this article include: stem nitrogen, stem potassium, leaf nitrogen, leaf potassium, plant nitrogen, plant potassium, nitrogen harvest index and potassium harvest index. During growth stage, tobacco leaves gradually start ripening from down. So at industrial ripening, leaves are harvested through 4 picks. The harvested leaves at every picks are first measured after carrying to saloon and the green leaves weight were recorded. Afterwards, the leaves were separately setup at the petiole over the cassettes and transferred to the Balk guring hot –house for drying. The leaves passed three steps of staining, fixation and drying. The harvested stems were conveyed to the hot-house for three days for drying and then their weight was measured. Total nitrogen was determined by kejeldal method. In this method, existed nitrogen in plant was changed into ammoniac nitrogen through digestion of plant powder with mixture of sulphuric acid and salcilic acid. The produced nitrate was changed into salicil nitro acid in the vicinity of salcilic acid which itself is changed into salicil amino in the vicinity of sadium sulphate tio. Salicil amino is changed into Ammonium sulphate through with sulphuric acid. The proteinate nitrogen produces Ammonium shulphate with sulphuric acid in the vicinity of B catalyst (silinium, sadium sulphate and copper sulphate). During distillation process and in vicinity of concentrated NaOH, the ammonium separated from mixure and fixed in 0.1 normal sulphuric acids. The remained acid was measured via titration of 0.1 normal NaOH and then total nitrogen was calculated. For this purpose, 0.1g dried powder of tobacco was weighed and poured into digestion balloon. Afterwards, 10ml sulphuric acid + salcilic acid and 2g B mixture were added. The digestion started by putting funnel over balloon with low temperature. The heat was increased gradually until the solution turned into the light green, then the balloons were removed and cooled down. After cooling, the funnels were rinsed and water added to the solution. 25ml NaOH (40%) was poured into distillation set. Erlen Meyer flask contained 10ml sulphuric acid (0.1 normal) and 5 drops metyl red indicator+ blue metyl was put under refrigerant. The distillation ended when the volume of balloon reduced to 75ml.

Tobacco phosphorous measurement.

A little amount of tobacco is burnt in 550˚ C and then dissolved in warm water. The present ortho phosphate ion makes a yellowish complex by Ammonium molibdat and Ammonium vanadat which depends on ortho phosphate concentration has different colours. The phosphorous amount could be measured by colourmeter.

Needed solutions

1- Ammonium molibdat and vanadat in nitric acid.

22.5 g Ammonium molibdat hepta $(NH_4)_6MO_7O_{24}$,$4H_2$ added to 400ml warm water and add more water until it totals 1 liter,

1.2 g Ammonium vanadat NH_4 VO_3 is added to 300 ml concenterated nitric acid and add more water until it totals 1 liter.

The phosphorous 50p.p.m standard solution

0.2195 g KH_2PO_4 salt is dissolved in distilled water and add more water until it totals 1 liter. Three 100ml balloons were taken, add 20 ml Ammonium Molibdat and Ammonium vanadat, then add more water until it totals 1 liter.

Potassium was determined by flame photometer set. The ashes of different parts of plant was put in a 100ml balloon and 80 ml water added into it, then the balloons were put in Ben marry bath for 15 minutes at 80˚ C. more water added until it totals 100ml. After filtering the solution, 5 ml of filtered extract poured into 200ml balloon and added more water until it totals 1 liter. Since the flame photometer set was 15 p.p.m, so it adjusted on number 60. After reading 5, 10, 25 p.p.m standards which were prepared from potassium sulphat, the amount of potassium was determined using flame photometer set in terms of grams of dried tobacco.

After determining of leaf and plant nitrogen content, nitrogen harvest coefficient is calculated.

Nitrogen harvest index= absorbed nitrogen in leaf/ absorbed nitrogen in plant

After determining of leaf and plant potassium content, phosphorous harvest coefficient is calculated through following formula.

Phosphorous harvest index= absorbed phosphorous in leaf/ absorbed phosphorous in plant

Potassium harvest index= absorbed Potassium in leaf/ absorbed Potassium in plant

In order to variance analysis and mean comparison, SAS software was applied.

3. Results and discussion

Variance analysis indicated that cultivar and potassium effects, the interaction between cultivar and nitrogen, the interaction between cultivar and potassium, the interaction among cultivar and nitrogen and potassium on dried leaf yield were significant ($P<0.01$). Likewise, the interaction between nitrogen and potassium on dried leaf yield were significant ($P<0.05$).cv.K326 had more dried leaf yield with mean of 1745Kg/ha rather than coker347 with mean of 1612.81 Kg/ha (Table 2). With application of 200 Kg/ha P, more dried leaf yield was gained (mean 1746 Kg/ha) rather than using 150 Kg/ha K (mean of 1612Kg/ha) (Table 5). The highest dried leaf yield was gained by using 55 Kg/ha nitrogen and 200 Kg/ha K which indicates positive fertilizer interaction. 55Kg/ha level and 150 Kg/ha K level (mean of 1659Kg/ha), 65 Kg/ha N level and 150 Kg/ha K level (mean of 1571 Kg/ha), 45 Kg/ha N level and 200 Kg/ha K (mean of 1564) and 35 Kg/ha N level and 150 Kg/ha (mean of 1550 Kg/ha) had the lowest dried leaf yield (Table 6). The greatest leaf dried yield (1957Kg/ha) was resulted in the interaction between cv.k326 and 35 Kg/ha N level. The interaction between cv.coker 347 and 35 Kg/ha N level had the least leaf dried yield with the mean of 1347 Kg/ha (Table 6).

The highest dried leaf yield was associated with the interaction between cv.coker 347 and 200 Kg/ha K level with the average of 1785 Kg/h, the interaction of k326 and 150 Kg/ha K level and the interaction between k326 and 200 Kg/ha K level with the average of 1734 Kg/h. The least leaf dried yield was related to the interaction of cv.coker 347 and 150 Kg/ha K level with the average of 1467 Kg/ha (Table 7). The interaction among cv.coker 347 and 65 Kg/ha N level and 200 Kg/ha K level gained the most amount of leaf dried yield with average of 2093 Kg/ha and the minimum leaf dried yield was associated with the interaction among cv.coker 347 and 35 Kg/ha N level and 150 Kg/ha K level (1255 Kg/ha). The effects of nitrogen and potassium, the interaction among cultivar nitrogen potassium on stem dried weight ($P<0.05$) and the interaction between cultivar and nitrogen ($P<0.01$) were significant. (Table 1). 200 Kg/ha K level had more stem dried weight with average of 1054Kg/ha compared to 150 Kg/ha K level with average of 930.30kg/ha (Table 4).

The interaction between cv.coker 347 and 55 Kg/ha N level had the highest stem dried weight with mean of 1309 Kg/ha and the least stem dried weight was related to the interaction between k326 and 65 Kg/ha N level (mean of 749 Kg/ha) (table 6). The interaction among cv. Coker 347 and 55 Kg/ha N level and 200Kg/ha K level was related to the greatest stem dried weight with mean of 1328 Kg/ha. The interaction among cv. K326 and 65 Kg/ha N level and 200Kg/ha K level had the least stem dried weight with 670.9 Kg/ha mean.(Table 8). The effects of nitrogen and potassium, the interaction between cultivar and nitrogen, the interaction between cultivar and potassium, the interaction between nitrogen and potassium, the interaction among cultivar, nitrogen and potassium on biomass were significant ($P<0.01$) (Table 1). 35 Kg/ha N level had the highest biomass with the average of 2915Kg/ha. 45.55 and 65 Kg/ha with respectively means of 2693, 2562 and 2515 were on the next classes. 200 Kg/ha potassium level with 2801 Kh/ha had more biomass compared to 150Kg/ha K (2542 Kg/ha) (table 4). The interaction between 55 Kg/ha N and 200 Kg/ha K with average of 3155 Kg/ha had the highest amount of biomass. The least biomass with averages of 2483, 2430 and 2408 were respectively related to the interaction between 35 Kg/ha N and 150 Kg/ha K, the interaction between 45 Kg/ha N and 200Kg/ha K and interaction between 65 Kg/ha N and 150 Kg/ha K (Table 5). The greatest amount of biomass belonged to the interaction between 35 Kg/ha N and cv. K326 and the interaction between 35 Kg/ha N and cv. Coker347 with respectively means of 3172 and 3151 kg/ha. The interaction between 35 Kg/ha N and cv. Coker 347 with average of 1213 had the lowest biomass.(table 6). The interaction between 200 Kg/ha K and cv. Coker 347, the interaction between 150 Kg/ha N and cv. Coker 347 and the interaction between 200 Kg/ha K and cv. Coker 347 respectively with averages of 2868, 2734 and 2685 Kg/ha had the highest amount of biomass. The interaction between 150 Kg/ha K and cv. Coker 347 was in the next class with 2399 Kg/ha. (Table 7).

The interaction among k326 and 35 Kg/ha N and 200 Kg/ha K level had the highest amount of biomass with 3403 Kg/ha and the least amount of biomass with 2150, 2090 and 2025 Kg/ha were associated with respectively the interaction among cv.coker 347, 65 Kg/ha N level and 150 Kg/ha K level, the interaction of k326, 65 Kg/ha N level and 200 Kg/ha K level and the interaction of cv. Coker 347 and 35 Kg/ha N and 150 Kg/ha K level (Table 8). Cultivar k326 had the higher stem nitrogen with 0.9175 than coker 347 with 0.811%. (Table 2). 65 Kg/ha N level, 55 Kg/ha N level, 45 Kg/ha N level with 0.873% had the greatest stem nitrogen and were in the same class. The lowest stem nitrogen with mean of 0.769% belonged to 35 Kg/ha N. (Table 2). The highest stem nitrogen with mean of 0.995 % resulted in the interaction between k326 and 45 Kg/ha N level and the lowest stem nitrogen was related to the interaction between k326 and 35 Kg/ha N level with mean of 0.784%, the interaction between coker 347 and35 Kg/ha N (0.755%) and the interaction between coker 347 and 45 Kg/ha N with 0.750%.(Table 6).

The interaction between k326 and 200 kg/ha with mean of 0.978 had the most amount of stem nitrogen. The interaction between cv.k326 and 150 kg/ha K level with 0.857 %, the interaction between cv.coker47 and 150 kg/ha K level with 0.850% and the interaction between cv.coker47 and 200 kg/ha K level with 0.772% showed the lowest stem nitrogen. The interaction between cultivar and potassium, the interaction of cultivar and potassium and nitrogen on stem phosphorus were significant ($P<0.01$). The effect of nitrogen, the interaction between nitrogen and potassium, the interaction among years, cultivar and potassium and the interaction among years, nitrogen and potassium on stem phosphorus were significant ($P<0.01$). The firs year showed more stem phosphorus with average of 0.148% rather than second year with mean of 0.114%. (Table 1). 65Kg/ha N level had the highest stem phosphorus with 0.145% and the lowest amount belonged to 55 and 35 Kg/ha nitrogen level with mean of 0.123%. (Table 2). 65Kg/ha N level and 200 kg/ha K level had the most stem phosphorus with average of 162% and 45 Kg/ha N and 200Kg/ha potassium with 0.132 %, 45 Kg/ha N and 150Kg/ha potassium with average of 0.132, 65 Kg/ha N and 150Kg/ha potassium with 0.125 %, 55 Kg/ha N and 150Kg/ha potassium with average of 0.12% showed the least stem phosphorus and were in the same class (Table 5). The interaction between cultivar k326 and 200Kg/ha k level with mean of 0.145 % contained the highest amount of stem phosphorus and the interaction between cv.coker347 and 200kg/ha K level with 0.124% and the interaction between k326 and 150Kg/ha K level with average of 0.122 had the lowest stem phosphorus and were in the same class (table 7). The highest and the lowest stem phosphorus were respectively belonged to the interaction among k326 and 65 Kg/ha N level and 200Kg/ha k with average of 0.174% and 55Kg/ha N level and the interaction of 55Kg/ha N and 200Kg/ha K level with 0.095% (table 9). The effect of cultivar and nitrogen on leaf phosphorus was significant ($p <0.05$) (table 1). The interactions between cv.coker347 and 55kg/ha N (0.279%) and between cv.K326 and 45Kg/ha P (0.276%) had the greatest amount of leaf phosphorus.

The effect of cv. Coker347 and 45Kg/ha N with average of 0.224% was the least leaf phosphorus content. (table 6). The interactions between cultivar and nitrogen, cultivar and potassium, nitrogen and potassium on leaf potassium were significant ($p<0.01$).

The interaction among cultivar and nitrogen and potassium was also significant.($p<0.05$). cv. K326 had more leaf potassium (3.28%) and cv. Coker347 was in the second place with 2.95%. (table 2). The interaction between 35Kg/ha N and 150Kg/ha P was 3.55% and the interaction between 45Kg/ha N and 150Kg/ha K (2.61%) had the lowest leaf potassium content. (table 5). The interactions between cv.k326 and 65Kg/ha N, cv.coker347 and 35Kg/ha N, cv. K326 and 45Kg/ha, cv.k326 and 55Kg/ha N were 3.49, 3.35, 3.32 and 3.31 respectively and had the most leaf potassium content, and the least leaf potassium content was related to interaction between cv.coker347and 45Kg/ha N and interaction between coker347 and 65Kg/ha N with 2.66 and 2.63 % respectively, (table 6). The interaction between cv, coker347 and 150Kg/ha K possessed the greatest amount of leaf potassium with 3.47% and the interaction between cv.coker347 and 200 Kg/ha K with 2.79 had the lowest leaf potassium content (table 7). The interaction among cv.k326 and 35Kg/ha N and 150 Kg/ha N, the interaction among cv.coker347 and 55 Kg/ha N and 150 Kg/ha K, the interaction among cv.coker347 and 35 Kg/ha N and 200 Kg/ha K and the interaction among cv.coker347 and 65 Kg/ha N and 200 Kg/ha K with averages of 3.72, 3.38, 3.33, 3.32 and 3.15% had the highest plant potassium and the interaction among cv.coker347 and 65 Kg/ha N and 150 Kg/ha K with mean of 2.10% contained the lowest leaf potassium (table 8). The effect of nitrogen and interaction between cultivar and nitrogen on plant nitrogen on 1% level and effect of cultivar and interaction between nitrogen and potassium on 5% were significant (table 1). Cv. K326 has more plant nitrogen (4.03%) and cv. Coker347 stands on the second level (3.87%). (table 2). Levels of 65, 45 and 55Kg/ha N respectively with average of 4.06, 3.99 and 3.98% have the greatest plant nitrogen and the least plant nitrogen with 3.76% was associated with 35Kg/ha N level (table 3). The interaction between 65Kg/ha N level and 200Kg/ha K level and the interaction between 55Kg/ha N level and 200Kg/ha K level as well as the interaction between 45Kg/ha N level and 200Kg/ha K level respectively with means of 4.14, 4.11 and 4.09 % had the highest plant nitrogen. The interaction between 35Kg/ha N level and 150Kg/ha K level, the interaction between 35Kg/ha N level and 200 Kg/ha K level respectively with averages of 3.8 and 3.72% had the minimum nitrogen plant. (Table 5).

The interaction between cv.k326 and 45Kg/ha N level (4.25%) had the highest nitrogen plant. The minimum amount of nitrogen in plant (3.63%) was related to the interaction between cv. K326 and 35Kg/ha N level (Table 6). The effect of cultivar and interaction between cultivar and nitrogen on potassium content in plant on 1% statistical level and the effect of potassium and the interaction between nitrogen and potassium as well as the interaction among cultivar, nitrogen and potassium on 5% level were significant (Table 1). Cv. K326 has the greatest plant potassium content (6.91% and cv.coker stands on the second place (6.51%) (Table 2). 200kg/ha k level had the most plant potassium content (6.86%) and 150 Kg/ha K was on the second rank with average of 6.46% (Table 4). The interaction between 45Kg/ha N level and 200Kg/ha K level, the interaction between 65 Kg/ha N level and 200Kg/ha K level, the interaction between 55Kg/ha N level and 150Kg/ha K level as well as the interaction 35 Kg/ha N level and 200Kg/ha K level have the highest plant potassium content and the interaction 45 Kg/ha N level and 150Kg/ha K level (6.07%) had the lowest plant potassium content (Table 5). The interaction between cv.k326 and 65 Kg/ha N level had the highest plant potassium content (7.27%) and the lowest plant potassium content (6.24%) was related to the interaction between cv.coker 347 and 45 Kg/ha K. (Table 6). The interaction among cv.k326 and 45 Kg/ha N 200Kg/ha K level as well as the interaction among cv.k326 and 65 Kg/ha N 150Kg/ha K level with respectively 7.52 and 7.49 % had the most plant potassium content. The interaction among cv.coker347 and 65 Kg/ha N 150Kg/ha K level with average of 5.74% had the lowest plant potassium content. (Table 8). The interaction between cultivar and nitrogen and the interaction between cultivar and potassium ($p<0.01$) as well as cultivar effect ($P<0.05$) on nitrogen harvest index were significant (Table 1).

cv. coker 347 had more nitrogen harvest index (51.80%) and cv. K326 with 50.64% was on the second place. (Table 2). The interaction between cv.coker347 and 35kg/ha N level had the highest nitrogen harvest index and the lowest amount with average of 48.64% belonged to the interaction between k326 and 35kg/ha N level (Table 6). The interaction between cv.coker 347 and 200kg/ha K level had the highest nitrogen harvest index with average of 53.33 and the lowest amount was related to the interaction between cv.k326 and 200kg/ha K level with mean of 49.58% (Table 7). The interaction between cultivar and nitrogen, the interaction between cultivar and potassium and the interaction between nitrogen and potassium on potassium harvest index was significant ($P<0.01$).the effects of nitrogen and potassium as well as the interaction between nitrogen and potassium were also significant ($P<0.05$) (Table1). 55 and 35 Kg/ha N levels had the greatest potassium harvest index with averages of 47.98 and 47.94% and the least one was related to 65 Kg/ha N level with 44.71% (Table3). 150 Kg/ha K level had more potassium harvest index (47.47%) and 200Kg/ha K level was on the second place with average of 45.42 (Table 4). The interaction between 35 Kg/ha N level and 150 Kg/ha K level had the highest potassium harvest index (54.07%). The interaction between 45 Kg/ha N level and 150 Kg/ha K level and interaction between 35 Kg/ha N level and 200 Kg/ha K level with 42.23 and 41.81% average respectively had the lowest potassium harvest index. (Table 5).

The interaction between cv.coker347 and 35 Kg/ha N level, the interaction between cv.coker347 and 55 Kg/ha N level as well as the interaction between cv. K326 and 65Kg/ha N level had the highest potassium harvest index with respectively 49.02, 48,72 and 48,07% and least potassium harvest potassium belonged to the interaction between coker347 and 65 Kg/ha N (41.36 %) (Table 6). The interaction between k236 and 150 Kg/ha K level had the most potassium harvest index (50.22). the interaction between coker347 and 200Kg/ha K level, the interaction between coker347 and 150 Kg/ha K level and the interaction between k326 and 200 Kg/ha K level with respectively 46.30, 44.73 and 44.54% were in the next places. (Table 7). The interaction among cv.k326 and 35 Kg/ha N and 150 Kg/ha K had the most potassium harvest index (56.63%). The interaction among cv.coker347 and 36Kg/ha N level and 150 Kg/ha K, the interaction among coker347 and 65 Kg/ha N and 150 Kg/ha K as weel as the interaction among k326 and 35 Kg/ha N and 200Kg/ha respectively with 39.68, 37.38 and 37.09% had the lowest potassium harvest index respectivelety (Table 8).

It is obvious that the greatest plant materials contained nitrogen and this element is the most important part of plant structure (Khajeh, 2000). Nitrogen is part of amino acides composition which is in the proteins structural units. The nitrogen percentage in most of proteians is between 14-18%. The lack of nitrogen is the most common nutritional stresses (Salardinie, 1995). Nitrogen has specific importance among elements. Tobaccos absorb nitrate ions easily and keep it in the same shape in leaves. Nitrogen is turned into other compounds in root cells or sent to the xylem and carried to the other organs from there. Soil temperature, soil acidity and the type of used nitrogen are effective in nitrogen absorption amount and plant nitrogen content depends on nitrogen mobility in soil and its translocation and absorption in plants (Sabeti, 2003).

Well nourishment causes the darkness, width and juiciness of plant leaves. The darkness of leaves green color happens caused by an increase in chloroplast synthesis and paleness of it in plants which have insufficiency of elements because the chloroplasts have not been evolved properly and the grana numbers are not enough (Hagh Parast Tanha, 1991). Nitrogen is the most important minimum factor in most of the soils. The provision degree of this element is determined by the available nitrogen or the nitrogen which is going to be released (Khoda bandeh, 1994). Enzymes contained a long chain include a set of protein molecules and an inactive protein group which is mostly a little in demand element. Proteins are polymers of 20 amino acids which are connected by peptide bonds and forms different compounds with more molecular weight. Amino acides hold nitrogen amini factor connected to Alfa carbon and might have cyclic nitrogen like triptophan. Glutamine contains nitrogen in amidic group and adenine is and cyclic poorini base which have nitrogen in its cycle. Adenine is the part of most nucleotides and nucleoproteins like RNA and DNA. Nitrogen is also a structural part of Alkaloids supposed that they play nitrogen storing compound role. Nitrogen deficiency limited growing and division of cells (Shirdani, 2001).

One of the important effects of increasing nitrogen fertilizer is low storage of hydrocarbons in plants. The absorbed nitrogen is composed with cell hydro carbonic matters quickly and used them as carbon and energy source in order to provide amino acids and proteins. For this purpose, most parts of cellular wall composing calcium ‹celolosane, pektate, cellulose and legnin with low nitrogen are not able to produce enough mentioned materials. Meanwhile the cell which is produced in this condition gets bigger and has lots of water. New biochemical and physiological information about cationic effect, specially potassium shows that more than 60 enzymes are activate by cationic. The enzymes are productions of catalysts of plant materials which are very important in crop yield like starch and protein. Potassium is the most appropriate cationic for plant enzyme activation because it has extraordinary mobility in plant and its concentration is very much in nature and cell. The advantageous interactions between nitrogen and potassium is due to alkali metal effects on protein production. This effect is more observed especially between nitrate anion and potassium cation. Potassium absorption has positive correlation with severity of metabolism in plant. Existence of enough oxygen and carbon hydrates in plants is necessary for inevitability of potassium absorption. The green parts of plant indicate more severe absorption of potassium in lightness. Plant Potassium absorption has positive relation with increase of potassium ion concentration. The plantnet absorption depends on plant potassium content. The more there is potassium in plant, the less potassium absorption by plant would be. Potassium is stored a lot in vacuoles. The potassium does not form complex organic molecules and mostly acts as an enzyme activator or coenzyme for 46 enzymes. The excessive need of potassium is justified to some extent by Potassium consumption in a co factor shape. Potassium is also important in preserving of osmotic pressure and water absorption in plant. Plants lose less water by proper storing of potassium because potassium increases osmotic potential in plant and has positive role in shutting the stomata. Potassium also helps anion electric balance and very important in taking and transferring of them. Potassium is an essential nutrient for plants which is involved with amino acids and proteins synthesis. The effect of potassium in stomata cells is changing of their number which is the reason of their opening and closing. Potassium is very necessary because of its special role in cell membrane of stomata cells and its effect in adjusting cells potential (Salardinie, 1995). In addition to, potassium is activator of more photosynthesis and respiration enzymes (Ahmadi, 2001; Kasraie, 1987). Potassium has general ionic effect and necessary for increase of osmotic pressure and cell expansion and to some extent potassium could be substituted by Na, NH_4 and Rb. Potassium is a special activator factor for many enzymes and mostly used in energy transmission. This element is not used as a foundation of organic compounds (Khoda, 1994). Potassium has positive relation with some nutrients like nitrogen, phosphorous and sulphur (MalaKooti, 1994; Peigue, 1997). Potassium is much in demand element which is absorbed in an ion shape (Sarmadnia, 1994). It is very mobile in soil and plants but its mobility is between nitrogen and phosphorous. The total potassium absorption in tobacco is very high and in the next phases it will be decreased. Potassium absorption is more than mineral elements and tobacco absorbs it in a luxurious way. Potassium absorption is very high in initial growth steps but it will decrease rapidly in the next steps. Potassium fertilizer amount could be added double or tripled needed amount (Shahdi, 1999).

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Table 1. Average Decomposition of Variance Squares of the Studied Qualities

Changes sources (S.O.V)	Independence Degree	Dry Leaf Yield (kg/ha)	Stalk Dry Weight (kg/ha)	Biomass (kg/ha)	Nitrogen in Stalk (%)	Phosphor in Stalk (%)	Potassium in Stalk (%)	Nitrogen in Leaf (%)	Phosphor In Leaf (%)	Potassium In Leaf (%)	Nitrogen in Plant (%)	Phosphor in Plant (%)	Potassium In Plant (%)	Nitrogen Harvest Index (%)	Phosphor Harvest Index (%)	Potassium Harvest Index (%)
Variety	1	**	ns	ns	**	ns	ns	ns	ns	*	*	ns	**	*	ns	ns
Nitrogen	3	n s	*	**	**	*	*	ns	ns	ns	**	ns	ns	ns	ns	*
Potassium	1	**	*	**	ns	ns	**	ns	ns	ns	ns	ns	*	ns	ns	*
Nitrogen Variety ×	3	**	**	**	*	ns	**	**	*	**	**	ns	**	**	ns	**
Potassium Variety ×	1	**	ns	**	**	**	*	**	ns	**	ns	ns	ns	**	ns	**
Potassium × Nitrogen	3	*	ns	**	ns	*	**	*	ns	**	*	ns	*	ns	ns	**
Potassium × Nitrogen Variety ×	3	**	*	**	ns	**	ns	ns	ns	*	ns	ns	*	ns	ns	*

Table 2. Comparison of Average Effect of Variety for the Studied Qualities

Variety	Dry Leaf Yield (kg/ha)	Nitrogen in Stalk (%)	Potassium In Leaf (%)	Nitrogen in Plant (%)	Potassium In Plant (%)	Nitrogen Harvest Index(%)
Coker347	1612b	0/811b	2.95b	3.87b	6.51b	51.80a
K326	1745a	0.917a	3.28a	4.03a	6.91a	50.64b

Table 3. Comparison of Average Effect of nitrogen for the Studied Qualities

Nitrogen	Stalk Dry Weight (kg/ha)	Biomass (kg/ha)	Nitrogen in Stalk (%)	Phosphor in Stalk (%)	Potassium in Stalk (%)	Nitrogen in Plant (%)	Potassium Harvest Index (%)
35Kg/ha	1026	2915.8a	0.769b	0.123b	2.44b	3.76b	47.94a
45Kg/ha	900	2693.3b	0.873a	0.132ab	2.50b	3.99a	45.16ab
55Kg/ha	1144	2562.2b	0.904	0.123b	2.51b	3.98a	47.98a
65Kg/ha	898	2515.8b	0.911a	0.145a	2.72a	4.06a	44.71b

Table 4. Comparison of Average Effect of potassium for the Studied Qualities

Potassium	Dry Leaf Yield (kg/ha)	Stalk Dry Weight (kg/ha)	Biomass (kg/ha)	Potassium in Stalk (%)	Potassium In Plant (%)	Potassium Harvest Index (%)
150Kg/ha	1612b	930.3b	2542.27b	2.38b	6.46b	47.47a
200Kg/ha	1746a	1054.83a	2801.21a	2.71a	6.86a	45.42b

Table 5. Comparison of Average Interaction Effect of Nitrogen and Potassium Fertilizers for the Studied Qualities

Treatments	Dry Leaf Yield (kg/ha)	Biomass (kg/ha)	Phosphor in Stalk (%)	Potassium in Stalk (%)	Nitrogen in Leaf (%)	Potassium In Leaf (%)	Nitrogen in Plant (%)	Potassium In Plant (%)	Potassium Harvest Index (%)
×150KgK/ha 35KgN/ha	1550c	2483c	0.120b	1.99a	1.98b	3.55a	3.80b	6.61ab	54.07a
×200KgK/ha 35KgN/ha	1782ab	2902ab	0.125b	2.89a	1.95b	2.81cd	3.72b	6.76a	41.81d
×150KgK/ha 45KgN/ha	1666bc	2600bc	0.132b	2.40c	2.04ab	2.61d	3.89ab	6.07b	42.23d
×200KgK/ha 45KgN/ha	1564c	2430c	0.132b	2.61bc	2.15ab	3.37abc	4.11a	7.03a	48.09bc
×150KgK/ha 55KgN/ha	1659c	2676bc	0.121b	2.46c	1.96b	3.45ab	3.8ab	6.97a	49.92b
×200KgK/ha 55KgN/ha	1882a	3155a	0126b	2.56bc	2.15ab	3.04abcd	4.09a	6.65ab	46.03bcd
×150KgK/ha 65KgN/ha	1571c	2408c	0.127b	2.65abc	2.21a	2.91bcd	4.14a	6.62ab	43.67cd
×200KgK/ha 45KgN/ha	1756abc	2716bc	0.162a	2.79ab	2.04ab	3.21abc	3.97ab	6.98a	45.76bcd

Table 6. Comparison of Average Interaction Effect of variety and Nitrogen for the Studied Qualities

Treatments	Dry Leaf Yield (kg/ha)	Stalk Dry Weight (kg/ha)	Biomass (kg/ha)	Nitrogen in Stalk (%)	Potassium in Stalk (%)	Nitrogen in Leaf (%)	Phosphor In Leaf (%)	Potassium In Leaf (%)	Nitrogen in Plant (%)	Potassium In Plant (%)	Nitrogen Harvest Index (%)	Potassium Harvest Index (%)
35KgN/ha × coker347	1374d	839cd	1213d	0.755c	2.53abc	2.11abc	0.25ab	3.35a	3.89bcd	6.94abc	53.82a	49.02a
45KgN/ha × coker347	1534cd	888cd	2413cd	0.750c	2.52bc	1.96bcd	0.22b	2.66b	3.75de	6.24d	52.13ab	42.97bc
55KgN/ha × coker347	1842ab	1309a	3151a	0.861bc	2.29c	1.91cd	0.28a	3.18ab	3.80cde	6.53bcd	49.19cd	48.72a
65KgN/ha × coker347	1699bc	1047bc	2746b	0.879abc	2.64ab	2.14ab	0.26ab	2.63b	4.05abc	6.38cd	52.06ab	41.36c
35KgN/ha k326 ×	1957a	1214ab	3172a	0.784c	2.35c	1.81d	0.25ab	3.01ab	3.63e	6.42cd	48.64d	46.86ab
45KgN/ha k326 ×	1696bc	911cd	2608bc	0.995a	2.48bc	2.23ab	0.28a	3.32a	4.25a	6.86abcd	52.05ab	47.35ab
55KgN/ha k326 ×	1699bc	980bcd	2679bc	0.947ab	2.72ab	2.19a	0.25ab	3.31a	4.17ab	7.09ab	51.44abc	47.23ab
65KgN/ha k326 ×	1629c	749d	2378cd	0.944ab	2.81a	2.09abc	0.24ab	3.49a	4.07abc	7.27a	50.41bcd	48.07a

Table 7. Comparison of Average Interaction Effect of variety and potassium for the Studied Qualities

Treatments	Dry Leaf Yield (kg/ha)	Biomass (kg/ha)	Nitrogen in Stalk (%)	Phosphor in Stalk (%)	Potassium in Stalk (%)	Nitrogen in Leaf (%)	Potassium In Leaf (%)	Nitrogen Harvest Index (%)	Potassium Harvest Index (%)
150KgK/ha coker347 ×	1467b	2399b	0.850b	0.132ab	2.39c	1.96b	2.79b	50.28bc	44.73b
200KgK/ha coker347 ×	1785a	2868a	0.772b	0.124b	2.59b	2.12a	3.12ab	53.33a	46.30b
150KgK/ha k326 ×	1757a	2685a	0.857b	0.122b	2.36c	2.13a	3.47a	51.69b	50.22a
200KgK/ha k326 ×	1734a	2734a	0.978a	0.145a	2.82a	2.03ab	3.09ab	49.58c	44.54b

Table 8. Comparison of Average Interaction Effect of variety and nitrogen and potassium for the Studied Qualities

Treatments	Dry Leaf Yield **(kg/ha)**	Stalk Dry Weight **(kg/ha)**	Biomass **(kg/ha)**	Phosphor in Stalk **(%)**	Potassium In Leaf **(%)**	Potassium In Plant **(%)**	Potassium Harvest Index **(%)**
× 150KgK/ha coker347 × 35KgN/ha	1255h	769de	2025f	0.128bcde	3.38a	6.66abcdef	51.50ab
× 200KgK/ha coker347 × 35KgN/ha	1494efgh	908bcde	2402def	0.120bcde	3.32a	7.23abc	46.54b
× 150KgK/ha coker347 × 45KgN/ha	1559efgh	825de	2384def	0.135bcd	2.33bc	5.93ef	39.68d
× 200KgK/ha coker347 × 45KgN/ha	1509efgh	952abcde	2461def	0.131bcd	2.98ab	6.55abcdef	46.26bc
× 150KgK/ha coker347 × 55KgN/ha	1747cde	1289ab	3037abc	0.142abc	3.33a	6.64abcdef	50.36b
× 200KgK/ha coker347 × 55KgN/ha	1937abc	1328a	3265ab	0.095e	3.02ab	6.42bcdef	47.07b
× 150KgK/ha coker347 × 65KgN/ha	1304gh	846cde	2150f	0.123bcde	2.10d	5.74f	37.38d
× 200KgK/ha coker347 × 65KgN/ha	2093a	1248ab	3342ab	0151bc	3.15a	6.91abcd	45.34bc
× 150KgK/ha k326 × 35KgN/ha	1845abcd	1096abcd	2942bc	0.124bcde	3.72a	6.56abcdef	56.63a
× 200KgK/ha k326 × 35KgN/ha	2070ab	1333a	3403a	0.119cde	2.29bc	6.284cdef	37.09d
× 150KgK/ha k326 × 45KgN/ha	1773bcde	1043abcde	2816cd	0128bcde	2.87abc	6.21def	44.80bc
× 200KgK/ha k326 × 45KgN/ha	1619def	780de	2399def	0.133bcd	3.75a	7.52a	49.92b
× 150KgK/ha k326 × 55KgN/ha	1527defh	743de	2315ef	0.101de	3.57a	7.29ab	49.49b
× 200KgK/ha k326 × 55KgN/ha	1827abcd	1216abc	3044abc	0.156ab	3.05ab	6.88abcde	44.98bc
× 150KgK/ha k326 × 65KgN/ha	1838abcd	827de	2666cde	0.132bcd	3.71a	7.49a	49.95b
× 200KgK/ha k326 × 65KgN/ha	1419fgh	670e	2090f	0.174a	3.28a	7.05abcd	46.18bc