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Full Length Research Paper

Effect of nitrogen and potassium fertilizer on yield, quality and some quantitative parameters of flue-cured tobacco cv. K326

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In order to investigate the effect of nitrogen and potassium fertilizers on yield, quality and some quantitative parameters 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 N/ha of pure nitrogen of urea source and potassium in two levels of 150 (K1) and 200 (K2) kg K/ha of potassium sulphate. The measured parameters in this experiment included leaf dry weight, leaf wet weight, stem height, stem diameter, leaf number in plant, leaf length, leaf width, stem dry weight, biomass, nicotine and sugar content. The effect of year on parameters such as leaf dry weight, leaf wet weight, stem height, leaf number, leaf length, stem dry weight, biomass and sugar content was significant ($P<0.01$). Likewise nitrogen had significant effect on leaf wet weight, leaf length, stem dry weight, biomass and sugar content at 1% statistical level and also on leaf dry weight, leaf wet weight, stem diameter, leaf width and stem dry weight at 5% statistical level. The interaction between year and nitrogen on parameters of leaf length (in 1% statistical level), leaf width and biomass (at 5% statistical level) was significant. In second year, more leaf dry weight, leaf wet weight, stem height, leaf number, stem dry weight, biomass and sugar content were obtained but the amount of leaf length and sugar content were greater in first year of experiment. The highest amount of leaf dry weight, leaf length, stem dry weight and biomass belonged to applying 35 kg N/ha and the greatest amounts of leaf wet weight and sugar content obtained when 35 and 45 kg N/ha was applied respectively. The greatest amounts of stem diameter and leaf width obtained when 35 and 55 kg N/ha was applied respectively. The highest sugar content was derived when 200 kg K/ha and was applied. Usage of 35 kg N/ha plus 200 kg K/ha led to the greatest amount of leaf dry weight, leaf wet weight, stem diameter, leaf number, leaf length and biomass. The highest amounts of leaf width and stem dry weight were gained when 35 kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 200 kg K/ha were applied.

Key words: Nitrogen, potassium, yield, quality, quantitative characteristics of flue-cured tobacco.

INTRODUCTION

The flue cured tobacco is known as a burning cigarette and Virginia tobaccos usually belong to this group of tobacco. Except few types, most of dried flue-cures tobacco are from Virginia type. But also some of the tobacco are cultivated as drys against the sun, drys against the fire tobacco. Virginia group is used for a wide class of neutral (non aromatic) tobaccos which has a little direct relation with the name of Virginia State of USA. Dried flue- cured tobacco is the only source of a special British cigarette which is different from other European-American common tobacco (Virginian). The stronger degrees of tobacco mostly were used for pipe tobacco (Ranjbar, 2005). Western types of tobacco belong to flue-cured tobacco which sufficient water and nutrients are needed for its cultivation and fertilizing lands by chemical fertilizers are necessary and inevitable. The main reason of using fertilizers is not just raising the crop yield and produced tobacco quality has also its own importance (Shamel, 1995). Fertilizer is a compound which directly and indirectly improves plant growth, tobacco quality degree and finally farmers' income. The farmers should be very aware of the quality of used fertilizers. In tobacco cultivation contrary to other crops, disproportionate fertilizers usage has not only positive effect, but also to some extent decreases tobacco quality and imposes economical damage on farmers so the amount of added fertilizers is very critical. On the other hand, using the same definite amount of fertilizers for all different crop lands does not seem logical because the fertility, texture and type of soils would differ (Fajri, 1998). The goal of tobacco farmers should be improvement of fertilizer program for fulfilling plant nutritional needs and reducing fertilizer costs and environmental effects. To approach this objective, farmers require a fertilizer plan based on soil examination to determine the quantity and availability of soil minerals. The fertilizer selection should be designed according to plant needs and level of soil productivity, fertilizer costs and proper application of fertilizers.

The excessive usage of fertilizers causes wasting of natural resources and nutrients and increases the probability of environment pollution outbreak as well as imposing high costs (Zargami, 2006). Nitrogen is one of the elements which is needed in all parts of plant life. Farmers are increasingly persuaded to use more nitrogen fertilizers in order to improve the crop yield because of the remarkable nutritional effect of nitrogen on yield and low nitrate nitrogen content in soils (Khodabandeh, 1997). The usual nitrogen content is between 2 to 5%. The nitrogen deficiency symptoms appear when nitrogen content is below 1.5% (Sabeti and Mohammad, 2004). More nitrogen content reduces starch storage and intensifies more formation of leaves nicotine. Low and insufficient nitrogen content limits nicotine formation and increases starch storage. This type of tobacco is undesirable and chemically imbalanced and has high sugar to nicotine ratio and produces tasteless smoke (Zargami, 2006). Potassium is in silicate form in soil and exists in igneous stones (granite and feldespat) or particles from their decomposition and seen on the surface of soil colloids or ions in soil solution (Ebrahimi, 2001). Tobacco cultivar TT5 was fertilized by different level of nitrogen and in order to determine free amino acid compound, fresh leaves were sampled after transplantation in each 2 weeks intervals. The main acids included proline, glutamic acid, alanine and asparat acid which composed 65 to 75% of free amino acids. Remarkable changes happened in quantity of proline and glutamic acid during growth stage. Glutamic acid was dominant at transplantation time and its quantity became maximum until 4 weeks before topping. Proline is just found in a little amount in fresh. The total amino acids content except glutamic acid got maximum amount before topping. The free amino acids content increases by adding more nitrogen but usage excessive nitrogen at the early growth stages led to low amounts of free amino acids compared to other treatments. Among tested free amino acids, proline was highly affected by nitrogen. Proline content got 20 times greater when more nitrogen was applied. The ratio of each amino acid (except proline and glutamic acid) to the total free amino acids in the same growth stage was not too high (Hu et al., 1985).

Compared to other tobacco growth stages, 45 days after transplanting leaves had the greatest nitrogen content. When nicotine and calcium was increased during tobacco growth, leaf nitrogen content was reduced. The correlation between leaf nicotine and potassium was negative (Patel et al., 1987). In order to investigate the effect of potassium on carbon metabolism and flue-cured tobacco quality, an experiment carried out in china. The results indicated that invertase and amylase activity during middle and final growth stages increased by adding proper amount of potassium. 60 days after transplanting, leaf carbohydrates content increased. Leaf sugar and starch content increased by adding more potassium in middle and final tobacco growth stages. Tobacco metabolism increased and more carbohydrate was stored by using more potassium in next tobacco growth stages and leaf potassium content increased at the same time (Gu et al., 1987). For investigating the effect of potassium (80, 200, 400, 600 and 800 kg K/ha) on topping on leaf potassium content, yield and quality of flue-cured tobacco cv. McNair12, a vase experiment conducted in India. Based on obtained results, leaf dry yield, green leaf yield, leaf degree value and burning rate increased by usage of 800 kg K/ha. The differences among nicotine, sugar and chloride content in topped plants and non topped ones were not significant. The upper and lower leaves had the most thickness due to applying 80 kg K/ha in topped plants and non topped ones. In control treatment, the middle leavers had the most thickness (Rao and Rao, 1993). In another experiment, different amounts of nitrogen and potassium fertilizers were applied and also the same nitrogen: potassium ratio was used for determining the level of CTK and ABA of flue-cured tobacco leaves in status of non absorptive bond enzyme. CTK level increase by leaf growth and gradually decreased by leaf ripening.

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The most CTK level was gained in leaf blade. But CTK levels was greater when more nitrogen and potassium were used compared to other treatments. ABA level of leaf blade increased during leaf growth and ripening. As a result, providing enough nitrogen and proper N:P:K ratio is very effective in production of flue-cured tobacco (Lin and He, 1999).

MATERIALS AND METHODS

In order to investigate the nitrogen and potassium fertilizers effects on yield, quality and some quantitative characteristics of flue-cured, tobacco cv. K326, a two year experiment conducted in 2008 and 2009 with 35 (N1), 45 (N2), 55(N3), 65 (N4) kg N/ha nitrogen from urea source and 150 (K1), 200 kg K/ha potassium from potassium sulphate source regarding common condition of region and experts advice in factorial design at 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 2007 and 2008, the nursery of tobacco seedling was prepared and then disinfected using vapan (0.1 L/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 to 1 cm thickness and seeds were scattered over 0.1 to 0.18 m^2 of nursery. From this time until transplanting of seedlings to the main field, all operations like irrigation, covering the nursery at nights, spraying pesticides were carried out. The field of experiment kept fallow the years before sowing and field providing activities such as fall tillage and rather deep spring tillage vertical to fall tillage were performed and 4 L/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 to 30 cm depth. After ploughing and primary leveling by hoe, the seedlings were transplanted in 6 lines when they were 20 to 50 cm high. The space between rows was 110 cm 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. Irrigation time was determined using a tensiometer based on suction power of 40 to 50 cm bar. Weeding control was performed twice.

In order to prevent Agrotis damages, Ambush and Noakran were used 1.4 L/ha respectively. 50% of remained fertilizer level was applied on two bands (the distance between bands was 10 cm) in 10 cm depth of soil. Topping in tobacco is one of the most important performances for growth and evolution of remained leaves of plant and their quality. In this experiment, topping was performed when 50% of plants reached flowering stage. For this purpose, all flowers plus 2 to 3 terminal leaves were cut. Afterwards, in order to prevent lateral buds from growing and evolving, maleic hydrasid containing potassium salt was sprayed over plants. The investigated parameters in this article include: leaf dry weight, leaf wet weight, stem height, stem diameter, plant leaf number, leaf length, leaf width, nicotine and sugar content. Tobacco leaves ripen gradually from bottom during growth stages. 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 cassetes and transferred to the Balk Gurin hot –house for drying. The leaves passed three steps to give color, fixation and drying. The harvested stems were conveyed to the hot-house for three days for drying and then their weight was measured. The plant leaf number was recorded by counting of leaves. Leaf length was measured from soil surface to the top of inflorescence by ruler.

In order to measure the stem thickness, 30 to 40 cm above the soil surface was considered and measured by caliper. Leaf number was recorded by counting. Leaf length was measured from initiation of petiole to the tip of leaf by ruler and the widest part of leaf was considered as a leaf width and measured. The auto analyzer set was used for measuring sugar and nicotine content and the measurement method was based on Porine ring or Cyanojen formation. This complex produces yellow color in the vicinity of aniline buffer and could be measured by chlorimeter set in 460 nm wave-length. For measurement of reductive sugar percentage, reactions of reductive sugar were used, that the yellow color of Cyanid Ferric weakens through reductive sugars. The weakening of color depends on the amount of reductive sugars existed in extract which is measurable in chlorimeter set. In order to determine leaf sugar and nicotine content, 0.1 g milled tobacco leaf sample was solved in100 ml distilled water and stirred for 20 min by shaker set. The derived extract was poured into auto analyzer dishes and measured after filtering. Analysis of variance and means comparisons were done by SAS software.

The effect of year

Variance analysis indicated that the effect of year on parameters like dry leaf yield, wet leaf yield, stem height, plant leaf number, stem diameter, leaf length, stem dry weight, biomass, nicotine and sugar content was significant (P<0.01) (Table 1). The amounts of dry leaf yield and wet leaf yield in second year (1976 and 16539 kg/ha) was more than first year (1575.5 and 12296 kg/ha). The stem height in the second year (13.635 cm) was higher than the first year (94.154 cm). In the second year more leaf number (30.75) was produced compared to the first year with average leaf number of 24.01. The average of leaf length in the first year (43.98 cm) was longer than second year (39.69 cm). More stem dry weight (1107.3 kg/ha) and biomass (3083.3 kg/ha) were recorded in the second year compared to the first year with average weight of 820.7 and 2336.2 kg/ha respectively. More nicotine content in the second year with average of 3.18% was recorded compared to the first year with average of 1%. Likewise the average amount of sugar content in the second year (16.84%) was higher than this rate in the first year (10.60%) (Tables 2 and 3).

The effect of nitrogen

Nitrogen had significant effect on parametersof green leaf yield, leaf length, stem dry weight, biomass and sugar content at 1% statistical level. On 5% statistical level, nitrogen had also significant effect on dry leaf yield, stem diameter and leaf width (Table 2). The greatest amount of dry leaf yield with average of 1957 kg N/ha was produced when 35 kg N/ha was applied. Applying 55, 45 and 65 kg N/ha led to 1669.9, 1696.3 and 1629 kg/ha dry leaf yield respectively which belonged to the second class. The greatest green leaf yields (17367 and 15168 kg/ha) were obtained by applying 35 and 45 kg N/ha respectively. Applying 65, 55 kg N/ha led to 12746 and 12390 kg/ha wet leaf yield respectively which belonged to the second class. The longest leaf length (44.52 cm) was recorded in a treatment which 35 kg N/ha was utilized. Averages of 42.92 and 42.38 cm leaf length were derived in treatments which 45 and 55 kg N/ha was applied respectively. The least leaf length was seen in a treatment that 65 kg N/ha was utilized. The most leaf width with averages of 19.61 and 19.31 cm were measured when 35 and 55 kg N/ha were used respectively. The least leaf width (17.5 cm) was seen when 45 kg N/ha were used. The highest stem diameters with the averages of 23.06 and 23.24 mm were associated with usage of 35 and 45 kg N/ha respectively. The second rate of lead width (22.208 mm) was associated with usage of 45 kg N/ha. The least leaf width (21.51 mm) was related to the usage of 65 kg N/ha.

Table 1. Average decomposition of variance squares of the studied qualities.

Suger	Nicotin	Biomass	Stalk dry weight	Leaf width	Leaf length	Leaf number	Stalk diameter	Stalk height	Green leaf yield	Dry leaf yield	Changes sources (s.o.v)
467.8379441**	166145333.3**	6697602.083**	98623.802**	6453333.33	220.7634083**	544.5921333**	5.10255208	4554.03440**	216032345.0**	2544262.521**	Year
10.5395896**	0.15549722	1341879.944**	448396.561**	7.36833333*	40.6360750**	11.0224278	7.94229097*	414.117786	64663730.9**	252327.743*	Nitrogen
30.4868441**	0.36053333	29205.333	63267.997	0.40333333	4.1654083	5.2668750	6.49005208	215.222700	12629034.2	6417.187	Potassuym
0.9054308	0.45508889	1239942.944**	352951.371*	10.89722222*	36.8558528**	28.5269139**	10.39511319*	466.166767	27800245.6*	313240.632*	Potassium × nitrogen
0.7006507	0.18553333	455475.583*	110173.170	8.03055556*	40.6360750**	12.0754833	6858957.64	188.600564	3475821.7	123646.854	Nitrogen × year
0.8677941	0.37100833	81510.083	10111.149	0.27000000	23.1574083	0.0252083	6.49005208	22.742533	503275.5	3397.521	Potassium × year
2.2954519	0.13547500	56263.368	3320.714	4.81944444	6.4878528	2.5895806	0.76733542	30.783267	2885628.4	40143.965	Potassium × nitrogen × year

Table 2. Comparison of average effect of year for the studied qualities.

Suger	Nicotin	Biomass	Stalk dry weight	Leaf length	Leaf number	Stalk height	Green leaf yield	Dry leaf yield	Year
10/60^{b}	2.18^{a}	2336.2^{b}	820.7^{b}	43.98^{a}	24.01^{b}	113.64^{b}	12296^{b}	1515.5^{b}	First
16/84^{a}	1.00^{b}	3083.3^{a}	1107.3^{a}	29.69^{b}	30.75^{a}	113.64^{a}	16539^{a}	1976.0^{a}	Second

Table 3. Comparison of average effect of nitrogen for the studied qualities.

Suger	Biomass	Stalk dry weight	Leaf width	Leaf length	Stalk diameter	Green leaf yield	Dry leaf yield	Nitrogen
14/82^{a}	3172.7^{a}	1214.9^{a}	19.31^{a}	44.52^{a}	23.06^{a}	173671^{a}	1957.7^{a}	35
13/96^{a}	2608.3^{b}	911.9^{b}	17.50^{b}	42.91^{ab}	22.22^{ab}	15168^{a}	1696.3^{b}	45
13/55^{ab}	2679.9^{b}	980.0^{ab}	19.61^{a}	42.37^{ab}	23.24^{a}	12390^{b}	1699.9^{b}	55
12/56^{b}	2378.1^{b}	749.1^{b}	17.99^{ab}	40.35^{b}	21.51^{b}	12746^{b}	1629.0^{b}	65

The greatest amount of stem dry weight (1214.9 Kg/ha) is allotted to the treatment in which 35 Kg N/ha was applied. The average stem dry weight of 980 Kg/ha was in the second class and obtained when 55 Kg N/ha was applied. The least stem dry weight with average weight of 911.9 and 749.1 Kg/ha was observed when 45 and 65 Kg N/ha was applied respectively. The greatest biomass with average weight of 3172.7 Kg/ha was obtained when 35 Kg N/ha was applied. The average biomass weights of 2679.9, 2608.3 and 2378 Kg/ha were in the second class and obtained when 55, 45 and 65 Kg N/ha were utilized respectively. The highest sugar content with averages of 14.82 and 13.96% were gotten when 35 and 45 Kg N/ha were applied respectively. 55 Kg N/ha level was in the second class by production of 12.56% sugar content. The least sugar content (12.56%) was determined when 65 Kg N/ha was applied.

The effect of potassium

Potassium showed significant effect on sugar content (P<0.01). Using 200 kg K/ha led to more sugar content (14.52%) compared to use of 150 kg K/ha which led to 12.93% sugar content (Table 4).

The interaction between nitrogen and potassium

The interaction between nitrogen and potassium on parameters such as leaf number, leaf length and biomass at the 1% statistical level and on dry leaf yield, green leaf yield, stem diameter, leaf width and stem dried weight

Table 4. Comparison of average effect of potassium for the studied qualities.

Suger	Potassium
12.93[b]	150
14.52[a]	200

at 5% statistical level was significant (Table 1). The greatest dry leaf yield with average weight of 2070 kg/ha was associated with using 35 kg N/ha plus 200 kg K/ha. Applying 35 kg N/ha plus 150 kg K/ha, 65 kg N/ha plus 150 kg K/ha and 55 kg N/ha plus 200 kg K/ha led to produce of 1845.3, 1838.7 and 1773.2 kg dry leaf yield per hectare respectively which lies on the second class.

The fertilizer levels of 45 kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 200 kg K/ha which led to 1619.5 and 1572 kg dry leaf yield per hectare respectively were in the third class. The least dry leaf yield (1419.3 kg/ha) was associated with usage of 65 kg N/ha plus 200 kg K/ha. The maximum green leaf yield with averages of 18094 and 16640 kg/ha belonged to fertilizer treatments of 35 kg N/ha plus 200 kg K/ha and 35 kg N/ha plus 150 kg K/ha respectively. Applying 45 Kg N/ha plus 200 kg K/ha, 65 kg N/ha plus 150 kg K/ha led to produce of 15501 and 14835 kg green leaf yield per hectare respectively which lies on the second class. Fertilizer levels of 55 kg N/ha plus 150 kg K/ha and 55 kg N/ha plus 200 kg K/ha placed in third class (12823 and 11957 kg green leaf yield per hectare respectively). The least green leaf yield (10067 kg/ha) was associated with fertilizer level of 65 Kg N/ha plus 200 kg K/ha. The highest stem diameter (24.42 mm) produced when 35 kg N/ha plus 200 kg K/ha was applied. Using 45 kg N/ha plus 200 kg K/ha, 45 kg N/ha plus 150 kg K/ha, 55 kg N/ha plus 200 kg K/ha, 35 kg N/ha plus 150 Kg K/ha, 65 kg N/ha plus 200 Kg K/ha led to average of 22.32, 22.10, 22.03, 21.7 and 20.70 mm stem diameter which is placed in the second class. The greatest leaf number (30.21 leaves) was associated with usage of 35 kg N/ha plus 200 kg K/ha.

The average leaf number of 28.68 which was produced under fertilizer level of 55 kg N/ha plus 200 kg K/ha was in the second class. Level of 45 kg N/ha plus 150 kg K/ha led to average leaf number of 27.83 leaves was in the third class. The fertilizer levels of 45 kg N/ha plus 200 kg K/ha, 35 kg N/ha plus 150 kg K/ha, 55 kg N/ha plus 200 kg K/ha, 65 kg N/ha plus 200 kg K/ha which lead to average leaf numbers of 27.25, 26.95, 25.58 and 24.72 leaves respectively were in next classes. The greatest leaf length with average of 46.28 cm obtained when 35 kg N/ha plus 200 kg K/ha was applied. Levels of 55 kg N/ha plus 200 kg K/ha and 35 kg N/ha plus 150 kg K/ha which led to 42.85 and 42.75 cm leaf length were in the second class. The third class of leaf length was associated with applying 45 kg N/ha plus 150 kg K/ha, 65 kg N/ha plus 200 kg K/ha, 45 kg N/ha plus 200 kg K/ha, 55 kg N/ha plus 150 kg K/ha which lead to average leaf lengths of 42.10, 42.03, 40.73 and 39.3 cm respectively. The minimum leaf length (38.67 cm) was observed in fertilizer level of 65 kg N/ha plus 200 kg K/ha. The maximum leaf width (19.42 cm) was seen in fertilizer levels of 35 kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 200 kg K/ha. Fertilizer levels of 65 kg N/ha plus 150 Kg K/ha, 35 kg N/ha plus 150 kg K/ha and 45 kg N/ha plus 150 kg K/ha which led to average leaf width of 19.1, 18.68 and 18.18 were all in the second class.

The least leaf widths (16.87 and 16.82 cm) were associated with fertilizer level of 65 kg N/ha plus 200 kg K/ha and 45 kg N/ha plus 200 kg K/ha. The maximum stem dry weigh with average weights of 1332.2 and 1216.9 kg/ha were associated with fertilizer levels of 35 kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 200 kg K/ha. The level of 35 kg N/ha plus 150 kg K/ha which led to average stem dried weight of 1096.7 kg/ha was in a second class. The third class of stem dry weight belonged to usage of 45 kg N/ha plus 150 kg K/ha by average stem dry weight of 1043.5 kg/ha. All fertilizer levels of 65 kg N/ha plus 150 kg K/ha, 45kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 150 kg K/ha which respectively led to average weights of 827.4, 780.3 and 743.2 kg/ha were in forth class. The least stem dry weight (670.9 kg/ha) was associated with usage of 65 kg N/ha plus 200 kg K/ha. The greatest amount of biomass (3043.2 kg/ha) was associated with usage of 35 kg N/ha plus 200 kg K/ha. The next classes were associated with fertilizer levels of 55 kg N/ha plus 200 kg K/ha, 35 kg N/ha plus 150 kg K/ha, 45 kg N/ha plus 150 kg K/ha, 65 kg N/ha plus 150 kg K/ha, 45 kg N/ha plus 200 kg K/ha and 55 kg N/ha plus 150 kg K/ha which led to average weights of 3044.5, 2942.2, 2816.8, 2666, 2399 and 2090.2 kg/ha respectively (Table 5).

The interaction between year and nitrogen

The interaction between year and nitrogen on leaf length was significant ($P<0.01$). This interaction on parameters such as leaf width, biomass was also significant at 5% statistical level (Table 1). Usage of 35 kg N/ha^{-1} per year led to the greatest leaf length with average of 49.17 cm. Applying 45 kg N/ha in the first year with average of 43.82 cm placed in the second class. Using 55 kg N/ha and 65 kg N/ha in the first year as well as 55 kg N/ha in the second year which led to average of 41.8, 41.15 and 40.35 cm leaf length respectively placed in third class. 35, 65 and 45 kg N/ha in the second year which led to averages of 39.87, 39.54 and 39.01 cm respectively had the minimum leaf lengths. The greatest leaf width (20.483 cm) was associated with usage of 35 kg N/ha in the first year. The second class belonged to applying 55 Kg N/ha in the second year, 55 kg N/ha in the first year, 65 kg N/ha in the second year and 45 kg N/ha in the first year which led to average leaf width of 18.667, 18.550, 18.55 and 18.417 cm respectively. The minimum leaf width was associated with usage of 35 kg N/ha and 65 kg N/ha which led to 18.133 and 17.417 cm leaf width respectively (Table 6).

RESULT AND DISCUSION

Similar to other living creatures, plants need nitrogen for growth and evolution. Most of plant nitrogen is in a shape of organic nitrogen and protein. Proteins are big molecular compounds that organize amino acids. These acids are bonded by amine and carboxyl groups. Protoplasm proteins are very important because they are able to remake themselves and produce other organic materials. The cellular protein is in shape of enzyme, chromosome and nucleoprotein. So they have activation and mediation role in plants and control metabolism function. There are plenty of proteins in seeds which are hydrolyzed at germination time and used for making new proteins in plants. Nitrogen is not only part of plants protein, but also it is a very necessary element in chlorophylls and used for carbon absorption. In hormones, nitrogen is transporter of respiration energy and adenosine triphosphate (Salardini, 2006). All plants are able to provide their nitrogenous needs by absorbing inorganic compounds like amino acids (especially asparatic and glutamic acids), asparagines, glutamine, urea, uric acid, alantoin (Ebrahimi, 2001). The most important nitrogenous compound which is absorbed by plants includes nitrates and ammonium which help plants absorb other nitrogenous organic compounds. Absorption

Table 5. Comparison of average interaction effect of nitrogen and potassium fertilizers for the studied qualities.

Biomass	Stalk dry weight	Leaf length	Leaf number	Leaf number	Stalk diameter	Green leaf yield	Dry leaf yield	Treatments
2942.2[b]	1096.7[ab]	18.68[ab]	42.750[a]	26.950[bcd]	21.70[b]	16640[a]	1845.3[ab]	N35K150
3403.2[a]	1333.2[a]	19.42[a]	46.283[a]	30.210[a]	24.42[a]	18094[a]	2070.0[a]	N35K200
2816.8[bc]	1043.5[abc]	18.82[ab]	42.100[abc]	27.838[ab]	22.10[b]	14835[ab]	1773.2[ab]	N45K150
2399.8[cde]	780.3[bc]	16.82[b]	40.73[bc]	27.245[abcd]	22.350[b]	15501[ab]	1619.5[bc]	N45K200
2315.3[de]	743.2[bc]	17.80[ab]	39.30[bc]	25.580[cd]	20.44[b]	12823[bc]	1572.0[bc]	N55K150
3044.5[ab]	12169.9[a]	19.42[a]	42.85[b]	28.678[ab]	22.03[b]	11957[bc]	1827.8[ab]	N55K200
2666.0[bcd]	827.4[bc]	19.10[ab]	42.03[bc]	27.830[abc]	22.32[b]	15425[ab]	1838.7[ab]	N65K150
2090.2[e]	670.9[c]	16.87[b]	38.67[c]	24.715[d]	20.71[b]	10067[c]	1419.3[c]	N65K200

Table 6. Comparison of average interaction effect of year and nitrogen fertilizers for the studied qualities.

Biomass	Leaf number	Leaf number	Treatments
3057.2[a]	20.483[a]	49.17	35 kgN/ha × first year (2008)
2266.2[b]	18.417[ab]	43.82[b]	45 kgN/ha × first year (2008)
2208.7[bc]	18.550[ab]	41.80[bc]	55 kgN/ha × first year (2008)
1812.8[c]	17.417[b]	41.15[bc]	65 kgN/ha × first year (2008)
3288.2[a]	18.133[b]	39.87[c]	35 kgN/ha × second year (2009)
2950.5[a]	16.583[b]	39.02[c]	45 kgN/ha × second year (2009)
3151.2[a]	18.667[ab]	40.35[bc]	55 kgN/ha × second year (2009)
2943.3[a]	18.550[ab]	39.54[c]	65 kgN/ha × second year (2009)

of these compounds is done at plants root but some times they are absorbed by plants leaves. Even Cyanamid compound which is poisonous for metabolism reactions can be absorbed by plants roots, leaves and stems. This compound prevents catalyses enzyme from activity. In normal condition, absorbed mineral nitrogen is digested quickly and changed into organic nitrogen compounds.

Almost all nitrogenous compounds have fairly proper mobility, so the first nitrogen deficiency signal is appeared in old leaves because in nitrogen shortage status, the nitrogen which was replaced in old leaves in a shape of protein is changed into soluble amino acid molecule under proteolyses process and transferred to the required location. Nitrogen is also called base physiologic fertilizer because increases pH after consumption and, makes cells acidic contrary to ammonium. Nitrates ions amplifies making organic acids in cells. It has been proved that organic acids quantity will be increased and decreased by nitrate and ammonium absorption respectively (Hagh, 1991). Nitrogen effect on tobacco is more than other elements but excessive usage of nitrogen increases leaf nicotine content and these leaves are not valuable for making cigarette. Additional, nitrogen in soil near the end of tobacco growth stage results in lateness of flowering, maturity and harvesting time. Basically, nitrogen deficiency reduces tobacco yield. On the other hand adding excessive nitrogen to the soil increases undesirable leaves nitrates. Reduction in nitrate levels of dried leaves would be possible by optimized management of nitrogen (Zargami, 2006). Adding excessive nitrogen does not have significant effect on increasing of plant yield and decreases the quality. Total nitrogen content has reversed relation with carbohydrates content.

Total nitrogen composes of 75% protein nitrogen, 10% alkaloids and 15% nitrogen which is existed in amino acids and other protein compounds (Ranjbar, 2005). Since a large amount of nitrogen is absorbed by plants, type of nutrition by nitrogen has a great impact on plants cation and anion ratio. For example, feeding plants by ammonium caused less absorption of other cations but amplifies anions absorption like phosphates. On the contrary, if plants are fed by nitrates, more anions will be absorbed consequently and causes other anions absorption and amplifies absorption of other cations (Ebrahimi, 2001). Nitrogen is the most restrictive element agent in crop production. Some plants like maize require more nitrogen so it is called heavy consumer. Nitrogen is one of key components of important molecules likes amino acids, proteins, nucleic acids and some hormones and chlorophyll. More symptoms of potassium deficiency include gradually growth reduction and general yellow color of plant leaves. Nitrogen is very mobile in plant. When older leaves get yellow and die, nitrogen would be translocated from old leaves to the younger ones in shape of soluble amine and amides (Pooran and Rahnama, 2000). Nitrogen is a very important element in growth and evolution of tobacco leaves and crop improvement which added to the soil in mineral and organic status. Organic materials in soil act as a hormone in changing of soil physical factors (Salardini, 2006). Nitrogen is the main production restrictive factor in most crop plants and after carbon, its assimilation has great importance. In majority of plants, the most nitrogen absorption is done at early quick growth stage and it is reduced by initiation of oldness and stages (Hagh, 1991). Nitrogen has more effect on yield and quality of tobacco compared to other elements. Low amount of nitrogen reduces yield and makes plant leaves yellowish and decreases leaves processing in high temperatures. An excessive nitrogen usage would cause increases yield a bit but might make mechanical harvesting and processing more difficult and delay ripening and prolong leaves processing and lead to more undesirable processed leaves and decrease of quality consequently.

An excessive quality also stimulates growth of lateral shoots which is fallowed by more usage of maleik hydrasid will be exacerbated. Nitrogen leaching ability is very much and excessive utilization of nitrogen leads to underground water pollution. More usage of nitrogen fertilizers results in accumulation of nitrates after harvesting. This situation could lead to increase of drinking water pollution (Ranjbar, 2005). One important effect of nitrogenous fertilizer increase is less storage of hydrocarbonic materials in plants. The absorbed nitrogen is rapidly bounded by hydro carbonic materials and uses them as energy and carbon source for production of amino acids and protein. As a result, in nitrogen shortage status, cell walls which contain calcium pektat, cellulosan, cellulose and legnin could not be built properly. Meanwhile, cell walls which have been built in this situation are very big and contain lots of water in their structures. Since nitrogen exists in many plant cell compounds like amino acids and nucleic acids, one of the nitrogen deficiency signals could be slow growth. In the beginning, potassium moves toward cell wall chambers of root cortex through mass flow and spread. Afterwards, potassium moves towards phloem through plasmatic membrane (Salardini, 2006). In addition to role of potassium to help plants transferring photosynthesis productions, it eases nitrogen movement and its changing into proteins. So potassium functions like nitrogen pomp and improve potassium abortion and consumption (Kavoosi, 2002). Potassium is absorbed in a shape of monovalency (K^+) and found abundantly in cells but does not have structural roles. Potassium concentration in phloem is very high. Stomata cells concentration is even more than potassium concentration but according to potassium ion is activator of many enzymes especially those involved in photosynthesis and respiration. Synthesis of starch and protein is affected by potassium deficiency. Potassium has very important role in controlling of plant cell potassium, plant movements such as opening and closing stomata, suit movement or daily leaves arrangements. Potassium concentration is higher in younger organs, roots (Ebrahimi, 2001).

Presence of potassium helps translocation of glucid materials to different organs and increase crop yield. On the other hand, potassium enhances plant resistance to pests and diseases and drought stress and leads to leaf color uniformity and well burning of tobacco leaves. Potassium alleviates the negative effects of excessive nitrogen of soil (Mohsen, 2000). In investigation of soil and plant and nutrients relations, potassium is very importance. Potassium forms a great percentage of earth's crust and minerals existing in soils and plants. Some plants such as tobacco absorbs potassium more than 5 times of their weight. Earth’s crust and crop soils contain around 2.3 and 1.4% K_2O respectively which is a significant quantity compared to other main elements. Among plant required cations, potassium is the biggest cation regarding its 1.33 angestrum atomic radius. K-O bond is not very stable in minerals structure because 8 to 14 molecules surround it. Polar ability of potassium is more than calcium, magnesium, lithium, sodium and less than ammonium, rubidium and barium. If other situations are the same, the more polar ability leads to the more exchangeable activities (Salardini, 2006). An experiment was done by 4 different seed levels (200, 300, 400 and 500 mg/m^{-2}) and 4 nitrogen amounts on randomized block design with 3 replications. Up to 400 mg seed per each meter square did not show any significant decrease but use of 500 mg seed per each meter square. On the other hand, using nitrogen up to 30 kg/ha led to linear increase in leaf area. The lowest number of seedling (174) and the highest number of seedling (263) obtained when 200 and 400 mg/m^2 seed was used respectively. An increase in nitrogen utilization up to 30 kg/ha led to increase in healthy seedling number. Compound effect of usage of 400 mg/m^2 seed plus 30 kg/ha nitrogen caused the greatest number of healthy seedling (Tripathi and Bhattacharya, 1983). In an experiment which was carried out in Pakistan, 3 different ways of applying fertilizers were investigated. Using ammonium nitrate led to relatively better quality of tobacco leaves with low nicotine and protein content and high amount of carbohydrate content.

The lowest value of nicotine and total protein in gathered leaves was seen when fertilizer scattered superficially (Khan et al., 1981).

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