Effect of macro elements on some traits of flue-cured tobacco cv.Coker347.

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Abstract

In order to investigate the effect of macro elements on yield and some quantitative traits of flue-cured tobacco cv.Coker347 an experiment was carried out in tobacco research institute of Rasht located in Guilan province on factorial based with 3 replications and 8 treatments. The applied fertilizer levels included 35 (N1), 45 (N2), 55 (N3) and 65 (N4) Kg/ha of pure nitrogen and potassium in two levels of 150 (K1) and 200 (K2) Kg/ha potassium. The measured parameters in this experiment included dry leaf yield (leaf dry weight), green leaf yield (leaf wet weight), leaf tissue hydration, plant height, stem diameter, biological yield (biomass) and harvest index. According to obtained results, effect of nitrogen on dry leaf yield, green leaf yield, and biomass was significant (P<0.01). Nitrogen had also significant effect on plant height and stem diameter (P<0.05). Potassium had significant effect on dry leaf yield and biomass (P<0.01). Potassium had also significant effect on green leaf yield and plant height (P<0.05). Interaction between nitrogen and potassium was significant on dry leaf yield (P<0.01).

Keywords: macroelements, yield, quantitative parameters and flue-cured tobacco.

Introduction

In spite of controversy over tobacco, it is accounted one of the most important crops all around the word. This crop has particular characteristics such as:

Tobacco is an inedible crop which is widely cultivated in the world
It has a great economic importance in many countries.

It is a biological material which has been studied and investigated so many times so that it encompasses a wide range of sciences like agronomy, physiology, biochemistry, medicine and pharmacology. From the perspective of plant science researchers, tobacco is a useful research tool in advanced research of biotechnology.

Tobacco is as important as Escherichiacoli from the view point of biological science (Tso, 1990). Most of commercial tobacco are from Nicotiana genus and Tabacom species.

From other genera, only N. rustica is cultivated in a small commercial area (Laythen and Nielsen, 1999). Cultivar of Coker347 belongs to Virginia larg-leaf western type of tobacco which is potent to produce 2200-2300 Kg dry leaf ha⁻¹ in proper agronomical conditions. 1100 hectares from total 1500 hectares of guilan province is under cultivation of Coker347. The rate of production in unit of area depends on soil productivity, available water content during growth period.

In Guilan climate Tobacco plant has the maximum water and nutrition needs during the fast growth period until flowering stage (late of may until late of August). Water and nutrition supply during this period is counted the necessity of proper crop production. Plant growth is affected by different factors such as soil, climate and genetic. Some of these factors are under control but most of them are not controllable. For example, human is not able to control weather, sun light and temperature but just can change the amount of nutrients. An
increase in amount of available nutrients would be possible through changing of soil condition and correct management as well as usage of chemical fertilizers. Successful production of plant products needs suitable soil and enough available nutrients. Nutrients should be compounds that plants can readily use and also the equilibrium between their amounts is very important. Plant growth won’t be continued naturally if one element does not exist or that it is not enough (Kochakiet al, 1993).

One important aspect in plant production is plant nutrition because desirable product is obtained when all needed elements are available for plants. Plant nutrition is related to preparation, absorption and distribution of plant needed elements which is practically possible by usage of chemical fertilizers (Hagh Parast Tanha, 1992). Tobacco nutrition by chemical fertilizers is one of important factors of its growth (Shamel Rostami, 2000). Nitrogen and potassium is very important elements in tobacco nutrition. Nitrogen is one of the very important macro elements. Tobacco absorbs nitrates ions very easily and keeps them in leaves. Nitrates are changed to other compounds in root cells or transferred to xylems and conveyed to other parts of plant from there. Soil temperature, acidity and type of applied nitrogen affect on nitrogen absorption rate by plant. Nitrogen rate in plant is related to nitrogen mobility in soil and its absorption and translocation (Mohsen zadeh, 2000).

The most important plant growth restrictive factor in agriculture is lack of nitrogen rather than deficiency of other elements because plants need nitrogen more than other elements.

The plants Nitrogen requirement is because of among existed atoms in plants, atoms, nitrogen atoms are the biggest. It should be considered although water deficiency is more important than nitrogen deficiency in plants, the water is necessary for providing a proper condition for plants actions and reaction not for its hydrogen (Salardinie, 1995).

Potassium is the only single-valence cations that functions as an activator for different enzymes, so it is very necessary for all organism (Zargami, 2006).

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 0.1-2 of total potassium. Quick-absorptive potassium exists in soil solution and will be absorbed easily by plants。( Shamel Rostami & Azad Mehr, 2001)

In an experiment in Andhrapradesh region of India, tobacco varieties of V-3189 and L-1158 were grown in cultivation spaces of 80 × 50 and 70 × 50 cm. 30, 40 and 50 Kg nitrogen ha⁻¹ were applied, control varieties of Jayasri and Hema were grown in cultivation space of 70 × 50 cm. According to obtained results, V-3189 and L-1158 produced the highest leaf yield by usage of 40 and 50 kg N ha⁻¹ respectively (Krishnamurthy et al, 1993). Another experiment was carried out in order to determine cultivation space and nitrogen suitable level for growth of McNair-12 cultivar of flue-cured tobacco in northern light soil of Andhrapradesh region of India. Based on results, significantly more high quality green leaves were produced in 1×0.5 cultivation space. Traits of yield, green leaf and desirability degree were increased by increasing nitrogen level from 50 to 90 Kg N ha⁻¹ and remained constant after that (Ramanchadram et al, 1995). An experiment was carried out in order to investigate the effect of nitrogen and cultivation density of eastern or Asian tobacco (erzogovima). 3 nitrogen levels (0, 30 and 60 Kg N ha⁻¹) and 3 cultivation density (55×26=69 930 plant/ha, 55×18=101 010 plant/ha and 55×14=129 870 plant/ha) were used in this experiment. Plant height, leaf number, leaf area, days from cultivation to flowering, leaf dry weight and technological value were studied in this experiment. All parameters except days from cultivation to flowering and leaf dried weight showed significant variation by nitrogen productivity during experiment years and were affected positively (Greco et al, 1999). In another experiment in India, effect of 3 nitrogen levels in 3 stages of topping on yield and tobacco quality (cv.6534) for 2 years was investigated. Results of combined analysis revealed that normal topping led to significant yield (1992 Kg/ha) rather than low or no topping. High degree of topping caused average yield of 1413 Kg/ha. Applying 60 Kg/ha nitrogen led to better yield rather than usage of 40 Kg N ha⁻¹ (Gridhar, 2000). In another experiment in which some potassium levels at different times were applied, different levels of potassium did not have significant effect on yield and quality. Besides, usage of potassium after cultivation did not have significant effect on increase of leaf potassium. Although there was an increase in leaf potassium content when more than 240 Kg K2O ha⁻¹ was used, this increase was not proportionate to applied potassium and it was not economical (Prasad Rao, 1995). An experiment was performed for investigating effect of fertilizer on yield and quality of Asian or eastern tobacco in Prilep institute of Macedonia for 2 years. Type of soil was Colluvium and soil acidity was normal. Soil contained organic materials, cloieds, phosphorus, low nitrogen and normal potassium. Treatments based on completed random design method included: 0 (control), N10P27.5K23, N16P55K40, N20P55K50, N30P82K75, N40P82K75, N50P82K75, N60P82K75, N20, N30, N40 and N50. Tobacco productivity at agro ecological condition of first year (more than 45.95% compared to control) had more
effect on yield compared to second year (15.01% compared to control). According to results of this study, effect of productivity on yield depends on year climatic conditions (Tobacco Institute, 1991). In order to determine the best cultivation space and fertilizer levels for flue-cured tobacco (K326) an experiment was carried out in the factorial based by applying 4 factors of density or plant number in 3 levels (16600, 20000 and 25000 plant/ha), pure nitrogen fertilizer in 2 levels (26 and 39 Kg/ha) from ammonium nitrate source, phosphorous (24 and 48 Kg/ha) from super triple phosphate and potassium in 3 levels (100,150 and 200 Kg/ha) from potassium sulphate on randomized complete block design with 36 treatments and 3 replications in Mazanderan province tobacco research institute. Results of variance analysis showed that effect of plant density on most of morphological, quantitative and qualitative of tobacco was significant (P<0.01). Interactions between potassium fertilizer amounts and plant density on average cost of 1 Kg tobacco were significant (P<0.05). Interactions between nitrogen and potassium on leaf number and green leaf weight (P<0.01) and leaf length (P<0.05) were significant. Interactions among phosphorous levels, potassium levels and plant density were significant on parameters like leaf number, plant height (P<0.01), stem diameter, leaf length, leaf sugar and phosphorus content (P<0.05).

Materials and methods

In order to investigate some macroelements effects on yield and some quantitative characteristics of flue-cured, tobacco cv.Coker347, a two year experiment conducted in 2008 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 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 of 2007, the nursery of tobacco seedling was prepared and then disinfected using vapan (0.1lit/m²) 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 and seeds were scattered over 0.1-0.18 m² 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 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 0-30 cm depth. 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 110 cm and between plants on rows was 55 cm. the space between plots and replicates 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 tansiometer based on suction power of 40-50 cm bar. Weeding control were performed twice. In order to prevent from Agrotis damages, Ambush and Noakran were used 1.4 liter per hectare 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 2-3 terminal leaves were cut. Afterwards, in order to prevent lateral buds Maleic hydrasidfrom , growing and evolvingcontanged potassium salt was sprayed over plants. The investigated parameters included: dried leaf yield (leaf dry weight), Green leaf yield (leaf wet weight), leaf tissue hydration, stem height. Stem diameter, plant dry weight (biomass) and harvest index. Tobacco leaves ripen gradually from down during growth stages. At industrial ripening, leaves are harvested through 4 picks tobacco leaves ripen gradually from down during growth stages. 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 colourize, fixation and drying. Leaf tissue hydration was calculated through following formula:

Leaf tissue hydration = leaf wet weight - leaf dried weight/ leaf dried weight \times 100

Stem height was measured by scaled ruler from soil surface to the top of the inflorescence in terms of cm. 30 - 40 cm over soil surface was counted as a measurement criterion. After weighing leaf dry weight and plant dry weight, harvest index was calculated through following formula:

Harvest index = economical yield (leaf)/biological yield (biomass) \times 100

Variance analysis and mean comparisons were done by MATATC and SAS software.
Results and discussion

Effect of nitrogen on dry leaf yield was very significant (P<0.01). Nitrogen is a necessary element in structure of amino acids, nucleotides, nucleoproteins and needed for plant growth and cell division. Lack of nitrogen inhibits the growth processes and causes getting yellowish and being short and dry yield reduction (Sarmadnia & Koochaki, 1994). Among nutrients, nitrogen has the highest production efficiency and simultaneously stimulates photosynthesis and chlorophyll formation. Nitrogen increases metabolism and facilitate osmosis of some amino acids from root. This condition accelerates absorption of other elements (Shamel Rostami & Azad Mehr, 2001). Nitrate reduction should be done before formation of amino acids and other nitrogen chemical compounds and this requires electron. Primary electron donors are nicotine amides (NADPH or NADH) which are from photosynthesis products. Higher Light intensity and photosynthesis rate are effective for function of nitrate reductase enzyme which is needed for nitrate reduction in plant tissues.

In woody plants, Nitrate reduction would occur only in roots but in plant crops it occurs both in leaves and roots (Shirdani Rad, 2001). Distinct effect of nitrogen (increase of shoot growth) is done when there are enough amounts of essential elements like potassium, phosphorus in soil (Hagh Parast Tanha, 1991). Organic nitrogen is the majority type of nitrogen in plant but more or less other nitrogen compounds like ammonium and nitrate ions would be found. Plant responses to nitrogen are as follows:

- Increase of plant green growth
- Increase of plant balanced development
- Increase of leaves green color intensity
- Increase of plant proteins rates

Nitrogen which is given to soil through mineral fertilizer is mixed with soil nitrogen. It means that part of it enters to organic compounds which will be given to plant later after mineralization. The more soil is active, the more mixing occurs and proper nitrogen would be available (Hagh Parast Tanha, 1991). Dry leaf yield has been affected significantly by potassium (P<0.01) (Table 1). It is considered that effect of potassium on a particular plant in two different soils would be varied even if there is the same available potassium content. The reasons could be included as follows:

1. Difference in soil moisture content.
2. Poor soil structure.
3. Different root growth rate.

A large amount of potassium is stored in vacuoles. Potassium does not make complex organic molecules but mainly activates 46 enzymes and co-enzymes. Potassium intake as a cofactor does not justify completely needs to high potassium. Potassium has an important role in osmotic potential maintenance and water absorption. Plants will lose less water if they have proper amount of potassium storage. Because potassium increases osmotic potential and has positive role in closing stomata. Potassium also helps to balance the anion charge and it is effective in water uptake and transmission (Sarmadnia, & Koochaki, 1994). In this case, cells have to uptake more water or protect existing water. This is particularly true for root and leaf cells. Thus plants which have been fed properly by potassium are able to use water more appropriately and prevent evaporation of leaves water. Positive effect of potassium ion in controlling water could be contributed to its rapid and selective uptake by Bean-shaped cells of stomata which leads to sudden changes in cell's cytoplasmic pressure and then rapid opening and closing of stomata. Synthesis of material with high molecular weight (proteins, starch, and cellulose) would be impaired in plants facing potassium deficiency and compounds with lower molecular weight are stored in vacuole. With increase of potassium intake, accumulated materials are transported to consumption places and different polymers will be composed (Shamel Rostami, 2000). High concentration of potassium in cells causes falling of freezing point and freezing risk will be reduced. Potassium ions are needed for maintenance of ribosome structural integrity. Perhaps somewhat high intracellular concentrations of ions could be attributed to this role of potassium ions (Ahmadi & Syoseh mordeh, 2001).

Potassium has a great role in regulation of plant cell potential and activation of enzymes which are essential in photosynthesis and respiration (Kafi et al, 2000). The maximum crop need for potassium is during growth time. Potassium accelerates transportation of organic materials and causes evolution of fresh cells and increases photosynthesis as well. Potassium role in plants becomes more important when there is more dement for increase of yield especially while other essential elements such as water and nitrogen are prepared. The interaction between nitrogen and potassium on dry leaf yield was significant as well (P<0.01) (Table 1). based on means comparisons table of simple effect of nitrogen and potassium fertilizers, the lowest crop yield (1240.33 and 1367 Kg ha⁻¹) was gained when 35 and 45 Kg N ha⁻¹ applied respectively. The highest dried leaf yield was obtained by utilizing 55 and 66 Kg N ha⁻¹ (1663 and 1603.17 Kg ha⁻¹ respectively). More usage of potassium up...
to 200 Kg K ha\(^{-1}\) caused 304.25 Kg more dried leaf yield rather than using 150 Kg K ha\(^{-1}\) (Table 2). According to results of studied interaction between nitrogen and potassium on dry leaf yield revealed that treatment of 8 (usage of 65 Kg N ha\(^{-1}\) plus 200 Kg K ha\(^{-1}\)) led to the highest yield (1994 Kg ha\(^{-1}\)). Treatment of 6 (usage of 55 Kg N ha\(^{-1}\) plus 200 Kg K ha\(^{-1}\)) was not significantly different from treatment 8. Treatment of 5 (usage of 55 Kg N ha\(^{-1}\) plus 150 Kg K ha\(^{-1}\)) which led to yield of 1518 Kg ha\(^{-1}\), placed on next classes. On one hand, treatments of 2, 3 and 4 (with average yield of 1337, 1389 and 1345 Kg ha\(^{-1}\) respectively) and treatment of 5 are in the same group, on the other hand Treatments of 2, 3, 4 and 7, 1 (the lowest yield of 1213 and 1144 Kg/ha respectively) are in the same group (Table 3). Effect of nitrogen on green yield was significant (P<0.05) (Table 1). Based on means comparisons table of simple effect of nitrogen and potassium fertilizers, usage of 55 Kg N ha\(^{-1}\) led to the highest green leaf yield (13530.3 Kg ha\(^{-1}\)). Usage of 65 and 45 Kg N ha\(^{-1}\) which led to average yield of 1196.7 and 10584.7 Kg ha\(^{-1}\) respectively, placed on second and third classes. Utilizing 35 Kg N ha\(^{-1}\) showed the least average yield of 9322.7 Kg ha\(^{-1}\). Applying 200 kg K ha\(^{-1}\) led to increase of green leaf yield (1455.2 Kg ha\(^{-1}\)) rather than usage of 150 Kg K ha\(^{-1}\) (Table 2). No significant difference was seen in effect of fertilizer treatments on leaf hydration (Table 1). All levels of nitrogen fertilizer (35, 45, 55 and 65 kg N ha\(^{-1}\)) with average percentage of 701.60, 662.35, 701.58 and 667.54% placed on the same group. Applying 150 and 200 Kg K ha\(^{-1}\) (average percentage of 723.45 and 667.54% respectively) did not lead to significant difference between them (Table 2). Effect of nitrogen on plant height is significant (P<%5). Effect of nitrogen on stem is due to an increase of internodes vegetative growth (Nozari, 2000). Potassium has shown significant effect on plant height (P<0.05) (Table 1). The greatest plant height (122.150 cm) was due to applying 55 Kg N ha\(^{-1}\). Fertilizer levels of 45 and 65 Kg N ha\(^{-1}\) which led to average height of 107.333 and 107183 cm respectively) placed on second group. The least plant height (96.22 cm) was gained when 35 Kg N ha\(^{-1}\) was used. Applying 200 Kg K ha\(^{-1}\) led to more 13.233 cm plant height rather than usage of 150 Kg K ha\(^{-1}\) (Table 2). Effect of nitrogen on stem diameter was significant (P<0.05) (Table 1). Applying 55 Kg N ha\(^{-1}\) caused the greatest stem diameter (25.83 mm). Average stem diameter of 24.100 and 23.433 were obtained when 65 and 45 Kg N ha\(^{-1}\) were used respectively. The lowest stem diameter (21.783 mm) was gained when 35 Kg N ha\(^{-1}\) was applied. For this trait (stem diameter) fertilizer levels of 200 and 150 Kg K ha\(^{-1}\) (average diameter of 24.600 and 22.975 mm) placed on the same group and there was no significant difference between them (Table 2). Effect of nitrogen and potassium on biomass was significant (P<0.01) (Table 2). Nitrogen increase biomass through affecting on dried material. Potassium has an important role on distribution and sharing of photosynthesis materials among different organs of plant. Potassium has an impact on dried material accumulation in plants more than nitrogen and less than phosphorous (Pirdashti, 1999). The highest amount of biomass (296.5 Kg ha\(^{-1}\)) was gained when 55 Kg N ha\(^{-1}\) was utilized. Fertilizer levels of 65 and 45 Kg N ha\(^{-1}\) placed on second and third classes respectively. The lowest biomass amount (200.7 Kg ha\(^{-1}\)) was obtained when 35 Kg N ha\(^{-1}\) was applied. Utilizing 200 Kg K ha\(^{-1}\) showed more biomass compared to using 150 Kg K ha\(^{-1}\) and placed on upper class. It could be concluded that biomass will be increased by increasing of nitrogen and potassium usage. There was no significant difference for harvest index trait (Table 1). Based on mean comparison table of simple effect of nitrogen and potassium fertilizers, all levels of 35, 45, 55 and 65 Kg N ha\(^{-1}\) were in the same class (Table 2). Likewise to fertilizer levels of 150 and 200 Kg K ha\(^{-1}\) were in the same class for this trait. dry leaf weight has positive and significant correlation (P<0.01) with traits such as green leaf weight, plant height, stem diameter and biomass. This trait had negative and insignificant correlation with leaf hydration. Green leaf weight had positive and very significant correlation with traits like: plant height, stem diameter, biomass and leaf hydration (P<0.01) and positive and insignificant correlation with harvest index. Plant height had positive and significant correlation with biomass (P<0.01). This trait had positive and insignificant correlation with leaf hydration and stem thickness and negative correlation with harvest index. Stem diameter had positive and significant correlation with biomass and positive and insignificant correlation with leaf hydration as well as negative correlation with harvest index. Harvest index had very negative and significant correlation with biomass and negative as well as insignificant correlation with leaf hydration. Biomass had positive and insignificant correlation with leaf hydration (Table 4).
### Table 1.

<table>
<thead>
<tr>
<th>Changes sources (S.O.V)</th>
<th>Degree Free</th>
<th>Dry leaf yield (Kg/ha)</th>
<th>Green leaf yield (Kg/ha)</th>
<th>Leaf tissue hydration (%)</th>
<th>Plant height (cm)</th>
<th>Stem diameter (mm)</th>
<th>Biomass (Kg/ha)</th>
<th>Harvesting index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat</td>
<td>2</td>
<td>208310.17</td>
<td>7283962.54</td>
<td>42059.26</td>
<td>574.72</td>
<td>0.88</td>
<td>1003172.17</td>
<td>96.40</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>3</td>
<td>236395.82</td>
<td>19649140.71</td>
<td>18754.45</td>
<td>680.77</td>
<td>6.38</td>
<td>1120841.82</td>
<td>60.40</td>
</tr>
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<td>Potassium</td>
<td>1</td>
<td>556626.04</td>
<td>12706515.38</td>
<td>3224.08</td>
<td>1050.73</td>
<td>2.04</td>
<td>1730355.04</td>
<td>0.77</td>
</tr>
<tr>
<td>Potassium + Nitrogen</td>
<td>3</td>
<td>180630.93</td>
<td>6930843.82</td>
<td>2777.43</td>
<td>83.63</td>
<td>1.17</td>
<td>347888.93</td>
<td>26.42</td>
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<tr>
<td>Error</td>
<td>14</td>
<td>25097.74</td>
<td>2387402.21</td>
<td>220511.08</td>
<td>174.95</td>
<td>1.54</td>
<td>142371.74</td>
<td>78.25</td>
</tr>
</tbody>
</table>

** Significant at 1% and 5% respectively, *

### Table 2 - Comparison of Average simple Effect of Nitrogen and Potassium Fertilizers for the Studied Qualities

<table>
<thead>
<tr>
<th>Studied Qualities</th>
<th>Dry leaf yield (Kg/ha)</th>
<th>Green leaf yield (Kg/ha)</th>
<th>Leaf tissue hydration (%)</th>
<th>Plant height (cm)</th>
<th>Stem diameter (mm)</th>
<th>Biomass (Kg/ha)</th>
<th>Harvesting index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>35</td>
<td>1662.67a</td>
<td>13530.3a</td>
<td>701.60a</td>
<td>122.15a</td>
<td>2967.5a</td>
<td>63.03a</td>
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<td></td>
<td>45</td>
<td>1603.17a</td>
<td>11961.7ab</td>
<td>662.35a</td>
<td>107.33ab</td>
<td>2637.2ab</td>
<td>62.40a</td>
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<tr>
<td></td>
<td>55</td>
<td>1367.00b</td>
<td>10584.2bc</td>
<td>701.58a</td>
<td>107.18ab</td>
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<td>61.94a</td>
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<td></td>
<td>65</td>
<td>1240.33b</td>
<td>9322.7c</td>
<td>716.45a</td>
<td>96.20b</td>
<td>2000.7c</td>
<td>56.16a</td>
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### Table 3 - Comparison of Average Interaction Effect of Nitrogen and Potassium Fertilizers for the Studied Qualities

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nitrogen</th>
<th>Potassium</th>
<th>Dry leaf yield (Kg/ha)</th>
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<tbody>
<tr>
<td>1</td>
<td>35</td>
<td>150</td>
<td>1144c</td>
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<tr>
<td>2</td>
<td>35</td>
<td>200</td>
<td>1337bc</td>
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<td>3</td>
<td>45</td>
<td>150</td>
<td>1389bc</td>
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<tr>
<td>4</td>
<td>45</td>
<td>200</td>
<td>1345bc</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>150</td>
<td>1518b</td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>200</td>
<td>1807a</td>
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<tr>
<td>7</td>
<td>65</td>
<td>150</td>
<td>1213c</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>200</td>
<td>1994a</td>
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### Table 4 – Correlation of Studied Qualities

<table>
<thead>
<tr>
<th>Dry leaf yield</th>
<th>Green leaf yield</th>
<th>Plant height</th>
<th>Stem diameter</th>
<th>harvesting index</th>
<th>Biomass</th>
<th>Leaf tissue hydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry leaf yield</td>
<td>1</td>
<td>894</td>
<td>574</td>
<td>252</td>
<td>197</td>
<td>848</td>
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<tr>
<td>Green leaf yield</td>
<td>1</td>
<td>590</td>
<td>254</td>
<td>155</td>
<td>724</td>
<td>502</td>
</tr>
<tr>
<td>Plant height</td>
<td>1</td>
<td>197</td>
<td>-0.95</td>
<td>333</td>
<td>177</td>
<td>0.004</td>
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<tr>
<td>Stem diameter</td>
<td>1</td>
<td>-146</td>
<td>1</td>
<td>-339</td>
<td>1</td>
<td>1</td>
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<tr>
<td>harvesting index</td>
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<td>-339</td>
<td>1</td>
<td>-0.40</td>
<td>1</td>
<td>0.001</td>
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</table>

<table>
<thead>
<tr>
<th>Leaf tissue hydration</th>
<th>1</th>
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</thead>
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