Effects of variety and plant spacing on weight, surface and yield of tobacco leaf (K326 and 347 Var.)

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Abstract: Tobacco is one of the important agricultural and industrial products which plays a crucial role in economics and income of the producing countries and tobacco's leaves are actually used commercially. In this study, the effects of two tobacco varieties K326 and 347 in three plant spacing of 30, 40, and 50 cm (with density of 33333, 25000 and 20000 plants/ha) on physical properties and weight of tobacco leaves are discussed. The results of variance analysis showed that the ¬¬¬effects of variety and plant spacing on leaf surface in 5% level were significant. Interaction effect of these two factors wasn't significant. Also results showed that independent and interaction effects of plant spacing and different varieties of tobacco on leaf weight were significant in %1 level. Overall, the mean comparison analysis indicated that weight of tobacco leaf was increased with increasing of plant spacing and this incensement in variety of 347 was more than that of K326 variety. The independent and interaction effects of plant spacing and different tobacco variety on yield were significant in %1 level. The highest and lowest amounts of tobacco yield were obtained for 347 variety in plant spacing of 30 cm and k326 variety in plant spacing of 50 cm, respectively. Generally, according to results the region conditions and economical values, tobacco variety 347 is recommended.

Keywords: tobacco, plant spacing, leaf, weight, yield.

Citation: Azadbakht, M., E. Ghajarjazi, A. Kiapei, H. Jafari, E.Salehi, and Reza Pishgar. 2016. Effects of variety and plant spacing on weight, surface and yield of tobacco leaf (K326 and 347 Var). Agricultural Engineering International: CIGR Journal, 18(3):220-224.

1 Introduction

Tobacco is one of the important agricultural and industrial products which plays an important role in the economics and income of the producing countries. Tobacco was first used as ornamental plant and sometimes as a drug to treat some diseases. In some villages, nicotine was used in pest control. Finally, industrial harvesting of this plant was conducted to prepare cigarette and tobacco products (Khajepour, 2004).Tobacco is a yearling plant and related to the family of eggplant and is of nicotiana's type which grows like a large and robust plant and leaves are used for commercial use (Ahifar, 1998). Optimum plant density is desired in a way that all environmental factors (water, air, light and soil) were fully utilized at the same time competition within and outside the plant were at minimum for the most desirable yield may be achieved with good quality (Khajepour, 1995). Weight of dry tobacco leaf is a qualitative feature and is mainly influenced by harvesting environment than genetic (Zhu et al., 2007). Ashkesh and Hodjati (1989) in determining the most appropriate harvesting space and its effect on the qualitative and quantitative properties of the Coker 347 reported that yield increased with decreasing plant spacing but dimensions of the leaves had an opposite effect with increasing plant spacing, the highest price of a kilogram tobacco and dimensions of leaves were obtained that total of 100 × 50 cm harvesting space (density of 20,000 plants/ha) was better than other

Received date: 2015-12-30 **Accepted date:** 2016-06-03

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treatments. By studying effects of plant density and fertilizer levels on agronomic traits and yield of tobacco variety of k326 was found that effect of plant density on yield and leaf length and width, plant height, stem diameter and leaf weight were significant at %1 level (Vaziri et al., 2010).The Effect of plant density on morphological and agronomic characteristics of tobacco leaves was studied. They reported that increasing the distance between plants from 45 to 55 cm in the row spacing of 100 cm, yield increase by 396.12 kg and higher economic value of approximately 861.10 $/ha. However, no significant price change was observed. Also length, width and leaf surface area of the ninth leaf at distance of 55 cm significantly increased. Overall, their results showed that high yield and high quality tobacco leaves with plant spacing was 55 cm (density of 18,000 plants/ha) (Bukan et al., 2010). In general, closer spacing of plants reduces the size, surface, thickness and weight of leaf per unit (Tisso, 1990). Several researchers have reported an increase in the yield with higher density (Chaplin and Campbell, 1993).So quality of leaves is usually lower due to reducing the amount of nitrogen (Chaplin, 1968).

Due to the increase in the cultivation of tobacco in Golestan Province of Iran, the aim of this study was to investigate the effect of the two varieties of k326 and 347 in plant spacing of 30, 40 and 50 cm on the physical properties of tobacco leaf and to determine the best plant spacing and varieties in this region.

2 Materials and methods

To study the effect of plant spacing and plant varieties on some physical properties of tobacco (weight and leaf surface), a factorial experiment was conducted based on completely randomized design with two factors: distance or space between plants (100 cm) at three levels: 30, 40 and 50 cm and two varieties of K326 and 347 with four replications during 2013-2014 cropping season in the field in Ali Abad Katoul, Iran. After preparing the land, triple superphosphate fertilizer at 100 kg/ha, ammonium nitrate at 100 kg/ha and sulphate of potash at 300 kg/ha were applied and mixing with the disc was done. Then 50 kg of phosphorus fertilizer were applied. After ditching (creating grooves for transplanting and watering after transplanting) transplanting operation was done on the ridges considering different plant spacing of 30, 40, 50 cm and irrigation was usually done within each 10 days.

Tobacco leaves in 5 picking were harvested at physiological maturity of crop. First pick was harvested on 1th September. After each harvest, the plants were irrigated and harvest interval was 10 days. After the second harvest, topping of tobacco flowers were performed in order to improve the growth of leaves (thick and heavy) with the sickle. Topping was took place in the second and third picking twice. Harvesting was usually done in the early morning when leaves are more succulent then dry leaves in the dryer were operated immediately. Dried tobaccos were moisturized in the drying system and then leaves were classified by the expert labors based on the quality and size of the leaves. The experiments were carried out at each stage as following:

Determination of the leaf surface area of two types of tobacco leaf varieties of K326 and 347 in the different densities includes software and hardware. HP scanner (model of 1200) was connected to a personal computer. First, the leaf's imaging was done in a very high quality and resolution scanner in a way that all the color differences between surface of the leaf and the bottom plate were clear. The images were saved in a permanent memory of the PC which had windows 8 and 8GB of RAM. Image J software, is a powerful application to analyze the images. This app is able to statistically calculate the surface area corresponding to chosen pixels of the images by the user (Ghajarjaziet al., 2015).

Then measured leaves in each density were weighted with a digital scale (Model: EK 200i, China) with accuracy of 0.01g.Finallyleaves of each density were put in containers and all containers were placed in the oven(Model: Memmert, accuracy of (± 5℃) for 72 h

then the percentage of moisture content was calculated by the Equation 1 (ASAE, 1999):

$$W = \frac{(m_1 - m_2)}{m_1} \times 100 \quad (1)$$

Where, m_1 is initial sample weight, $m_2$is sample weight after drying in the oven, W is percentage of moisture content, wb%.

Collected yield was scaled accurately in 100 m^2 area and then the results were generalized to a hectare. The obtained data were analyzed using Excel and SAS statistical program and means were compared by LSD test.

3 Results and discussion

3.1 Effects of variety and plant spacing on the surface of tobacco leaf

Analysis of variance showed that the independent effect of plant spacing on leaf area was significant at the 5% level (Table 1). Also interaction between these two factors had not significant effect on the leaf surface. This was consistent with findings of Bukanet al. (2010). The effect of planting spaces on leaf surface has been shown in Figure 1. According to that plant leaf surface area increased with increasing of distance.

Table 1 Analysis of variance of the effects of variety and plant spacing on leaf surface

Source of variation	Degrees of freedom	Mean square	F-value
Plant spacing	2	427980.25	20.3**
Variety	1	142877.17	6.78*
Plant spacing ×Variety	2	11265.56	0.59ns
Error	18	21082.69	

Note: **, * Significant statistical level of 1 and 5%, respectively, and ns not significant

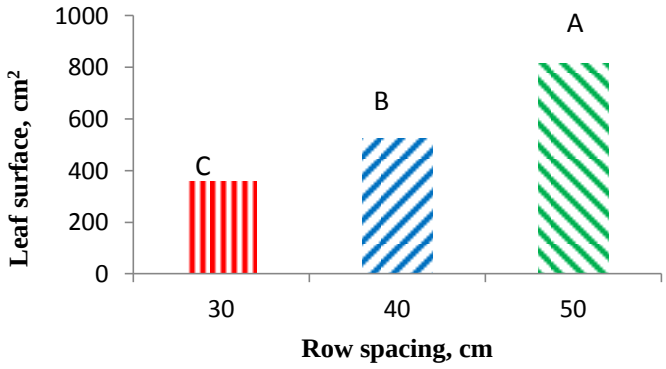

Figure 1 Effect of plant spacing on the leaf surface

As shown in Figure 2, variety 347 has a greater effect on the leaf surface.

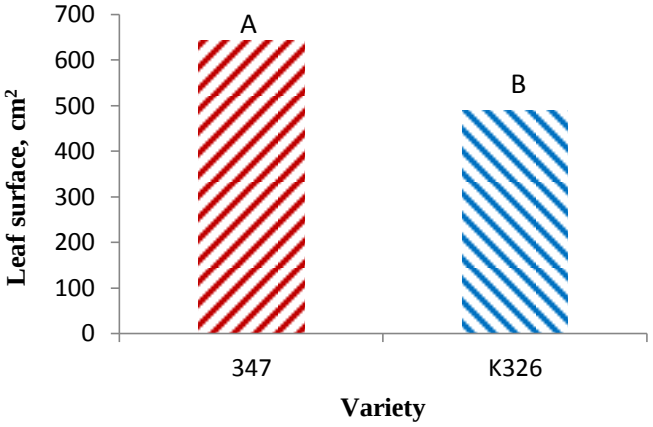

Figure 2 Effect of variety type on the leaf surface

3.2 Effects of varieties and plant spacing on tobacco leaf's weight

Variance analysis showed that the effect of variety and plant spacing were significant on weight of tobacco leaves at one percent level. Their interactions on leaf weight were significant at one percent (Table 2). To determine the effect of these factors on the weight of tobacco leaves they were compared using LSD Test method (Table 3).

Table 2 Analysis of variance of effect of varieties and plant spacing on leaf weight

Source of variation	Degrees of freedom	Mean square	F-value
Plants pacing	2	3493.6	119.72**
Variety	1	1984.35	68**
Plant spacing ×Variety	2	488.3	16.75**
Error	18	29.18	

Note: ** Significant statistical level of 1%

Table 3 Mean comparison of plant spacing in different levels and varieties on weight of the leaf

Variety	plant spacing, cm		
	30	40	50
K326	18.44^{Ca}	33.23^{Bb}	44.75^{Ab}
347	22.4^{Ca}	48.9^{Ba}	79.68^{Aa}

Note: Same small letters in each column and same capital letters in each raw show no significant different (LSD%1)

Long distances develop the growth of plant roots and leaves. It also enlarges and thickens the leaves and causes an increase in the weight of dry and green tobacco leaves. Although some investigators had not confirmed these findings (Ashkesh and Hodjati, 1989; Chaplin et al., 1968; Collins et al., 1993; Vaziri et al.,2010), but the results match with the tests conducted by Tso (1990).The comparison showed that the planting distance of 30 cm had no significant differences on leaf weight between the two varieties of K326 and 347 but planting distances of 40 and 50 cm had significant difference between the weights of leaves, so in both varieties the average weight of the leaves had an upward trend (Figure 3). Mean comparison table showed that in both varieties at planting spacing or intervals there was a significant difference (Table 3). As Figure 3 shows that with increasing distance in each variety, the tobacco leaf weight increased and rate of increase in tobacco 347 variety was higher than that of k326.

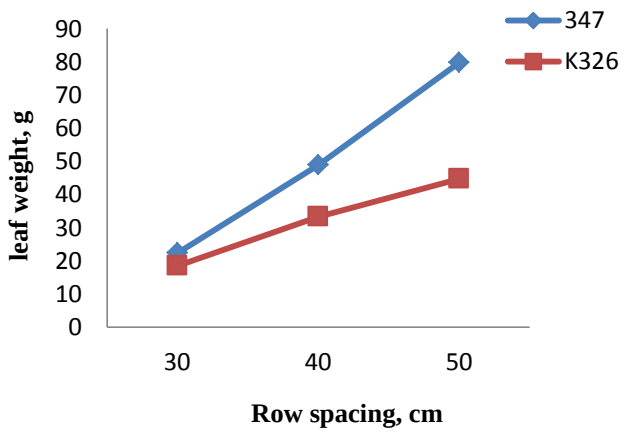

Figure 3 Effects of variety and plant spacing on tobacco leaf weight

3.3 Yield

The results of variance analysis (Table 4) indicated there is a significant relationship between the changes of plant spacing and the changes of varieties with tobacco yield at 1% probability level. Also, it was shown that there is a mutual effect between variety and plant spacing with yield at 1% probability level. Average comparison by LSD method was conducted to determine the effect of two factors on leaf weight. Table 5 provides the results.

Table 4 Variance analysis of the effect of variety and plant spacing on tobacco yield

Source of variation	Degrees of freedom	Mean square	F-value
Plantspacing	2	513550.79	8277.51**
Variety	1	233445.37	3762.72**
Plant spacing ×Variety	2	3159.12	50.92 **
Error	18	62.04	

Note: ** Significant statistical level of 1%

Table 5 Mean comparison of plant spacing and varieties on tobacco yield

Variety	plant spacing, cm		
	30	40	50
K326	3351.25^{Ab}	3103.75 ^{Bb}	2808.75 ^{Cb}
347	3522.5^{Aa}	3281.25 ^{Ba}	3051.75 ^{Ca}

Note: Same small letters in each column and same capital letters in each raw show no significant different (LSD%1)

As shown in Table 5, maximum and minimum amount of tobacco yield was respectively 3522.5 kg/ha and 2808.75 kg/ha at k326 and 347 variety levels and 30 cm and 50 cm plant spacing.

According to Table 5, there is a negative relationship between plant spacing and yield. It means that 30 cm plant spacing had the maximum yield. Also, it has been observed that variety 347 has higher yield than variety k326. Figure 4 shows the effect of variety in per plant spacing on tobacco yield. Alizadeh et al. (2013) studied the effect of plant spacing on tobacco yield of Barley variety. They observed that there is a negative relationship between plant spacing and yield. Vaziri et al. (2000) studied the effects of plant density and different fertilizer levels on agronomic characteristics and tobacco yield (k 326) and found a direct relationship between plant density and yield.

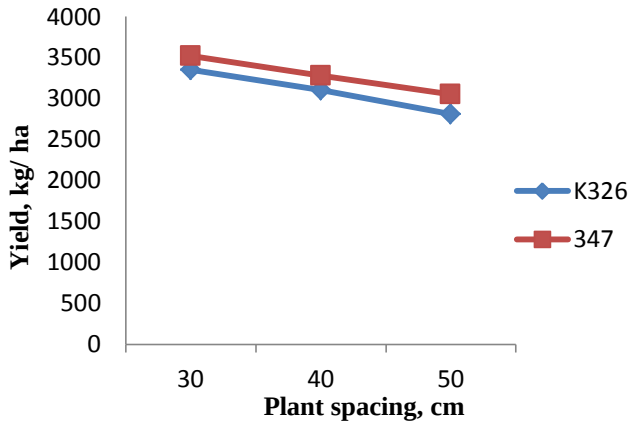

Figure 4 Effects of variety and plant spacing on tobacco yield

4 Conclusions

The results of the research indicated increasing of plant spacing will increase weight and the surface of tobacco leaf and it implies high quality of yield in low densities. Also, there is a negative relationship between plant spacing (high density) and yield, but leaf quality is lower than low density. Therefore, 30 cm plant spacing is better than 40 and 50 cm distances in terms of more production, but 50 cm plant spacing is better than 30 and 40 cm distances in terms of better quality of leafs for tobacco. Also, the results of the research indicated that tobacco of variety 347 is better than variety of K326 based on area, leaf weight and yield. Then variety 347 is better than k326 for cultivating tobacco. Proper distance between plant spacing could be selected based on wholesales' policies of the yield in terms of better yield or quality.

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