INTERNATİONAL JOURNAL OF AGRİCULTURE & BİOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
09–375/SBC/2010/12–3–369–372
http://www.fspublishers.org

Full Length Article

Impact of Different Nitrogen and Potassium Application on Yield and Fiber Quality of Ramie (*Boehmeria nivea*)

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ABSTRACT

Nitrogen and potassium are main mineral elements affect yield and quality in fiber plant production. Experiments to determine the effects of four nitrogen (0, 70, 140 & 210 kg/ha) and three potassium (0, 75 & 150 kg/ha) levels to fiber yield and quality of ramie plants were conducted in a two years field experiment. Stem number, plant height and stem yield were significantly affected by nitrogen applications. Potassium fertilization impact upon plant height and stem yield was observed, whereas stem number was not changed. Nitrogen significantly increased dry matter formation on stem and fiber yield of plants. Fiber length, fineness and strength were not changed appreciably by different nitrogen applications. Higher amounts of potassium fertilization contributed fiber strength but fiber yield did not change. It was concluded that nitrogen mostly improved plant growth and fiber yield while potassium had discernible effects on fiber quality. © 2010 Friends Science Publishers

Key Words: Ramie; *Boehmeria nivea*; Nitrogen; Potassium; Yield; Quality

INTRODUCTION

Ramie (*Boehmeria nivea)*, which provides high-quality fiber is used to make ropes, cloth and some industrial materials. Generally ramie is grown in China and some other Asian Countries including the Philippines and India (Liu *et al*., 2001). Although ramie can adapt most of the tropics and subtropics regions, it is only grown in few countries. The fiber obtained from ramie is known as one of the strongest vegetable fiber (Singh, 1992). Consequently, ramie fibers can increase strength, color and luster of cotton without compromising the flexibility of the fabric (Wang *et al*., 2007). Although the fiber properties of ramie has very similar with linen's, the process of dying and cutting is easier. Strong fibers can be obtained also from hemp plant. However, cultivation of hemp is limited and under controlled since illegal drug production. Therefore, ramie has a great potential because of its fiber properties, industrial advantages and widely adaptation capacity.

Nitrogen and potassium are primary nutrients for plant growth since they are involved in main biochemical processes. Beside of their crucial effects on plant growth and yield formation, feature and quality of final products are mostly affected. Mineral content of soil and fertilization practices in cultivation of fiber plants also affects qualitative properties of yield. Tewolde and Fernandez (2003) reported that length, elongation, micronaire and color characteristic of cotton fiber increased by higher rate of nitrogen application. Constructive effects of potassium on yield and fiber quality were also found in cotton (Cassman *et al*., 1990). Nitrogen and potassium fertilization were suggested for ramie production to obtain higher yield (Cabangbang & Zabate, 1978; Shengxian, 1998) and fiber quality (Macarayan, 2005). Zheng (1999) stated that balancing nitrogen and phosphorus with adequate potassium improve length, strength and fineness of fiber in both cotton and ramie. However, Bennet *et al*. (1965) reported negative correlation between level of potassium application and fiber quality of cotton. Mineral influences have been well documented regarding to fiber yield and quality of cotton, but there are few studies pointed out their effects on ramie and emphasized its fiber quality. In consideration of the plant part, where fiber is obtained, different interactions may be expected between mineral fertilization and fiber yield and quality in ramie since its stem based fiber formation. Response of generative and vegetative organelle of plants to mineral elements change. Therefore, fiber yield and quality as a result of generative and vegetative growth are expected to change differentially in cotton and ramie.

The main objective of this study was therefore, to determine response of ramie to different amount of nitrogen and potassium fertilizations in terms of plant productivity, fiber quality and their interactions.

MATERIALS AND METHODS

Plant materials were obtained from Antalya and Yeşilköy Agricultural Research Institute, Istanbul, Turkey. These genetic sources were introduced from USA 40 years ago. Field studies were conducted in the experimental fields

To cite this paper: Tatar, Ö., E. Ilker, F.A. Tonk, H. Aygün and Ö. Çaylak, 2010. Impact of different nitrogen and potassium application on yield and fiber quality of ramie (*Boehmeria nivea*). *Int. J. Agric. Biol.*, 12: 369–372

of Ege University Faculty of Agriculture Department of Field Crops, Turkey, during 2004 and 2005 growing season. Meteorological data for the experimental site during these two seasons are given in Fig. 1. The root segment (15 cm) was sown on March. The plants spacing was 100 cm between rows and 40 cm within rows. The experiments were designed in a split-plot design with three replications. Four nitrogen (0, 70, 140, 210 kg/ha) and three potassium (0, 75, 150 kg/ha) levels were treated. Total potassium was given as K_2SO_4 during young seedling stage of plants on April. NH_4NO_3 was used as nitrogen source and given in three times on May, July and August, respectively. These fertilizing applications were repeated for also second year of the experiment at the same period. Weeding and hoeing were carried out manually throughout the growth period. Irrigation was given depending on the soil water status. Ten plant samples were taken three times per year by the harvesting times (June, August & October). Plant height, fresh and dry weights of leaf and steam were measured of samples for each harvesting times. Cortex layer of stem of plants were separated and weighed to calculate crude fiber yield. Pectin and other mucilaginous components were removed by retting. Fibers obtained from this process were dried under sunlight and weighed. Then fiber yield was determined. Fiber fineness was measured by lanameter. A Pressley instrument was used for determination of fiber strength.

The data collected from the experiments for each character were statistically analyzed for F test (Steel & Torrie, 1980). Wherever, the treatment effects were observed significant at the 5% of significance, L.S.D. (least significant difference) was calculated to compare treatment effects.

RESULTS AND DISCUSSION

Nitrogen (N) and potassium (K) are main essential elements for most of the biological processes in a plant. Their individual effects and interactions on fiber plants were investigated in many studies (Mullins & Burmester, 1990; Zimmermann *et al*., 2006; Kumar *et al*., 2007). Usherwood and Segars (2001) reported that root development, dry matter production and other plant functions regulating crop yield and quality are improved by N interactions with K. In the present study, N amount impact upon stem number per plant was significant, whereas K has not clear effect. Higher stem number was recorded in N14 and N21 treatments (Fig. 2). Both N and K application significantly affected the plant height. Plant height markedly effected by both nitrogen and potassium applications. Higher amount of N and K fertilization (N210 & K150 kg ha^{-1}) caused highest increase in plant height (Fig. 2). It is well established that N improves plant height as a component of vegetative growth in many crop plants (Alam *et al*., 2002; Iqbal *et al*., 2007). However, Webber (1996) reported that N has no effect on plant height in Kenaf plant. Since K contributes in N use

Fig. 1: Meteorological conditions in the experimental site during, 2004 and 2005 seasons

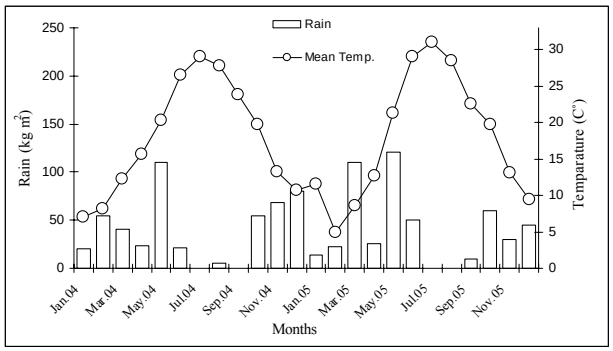
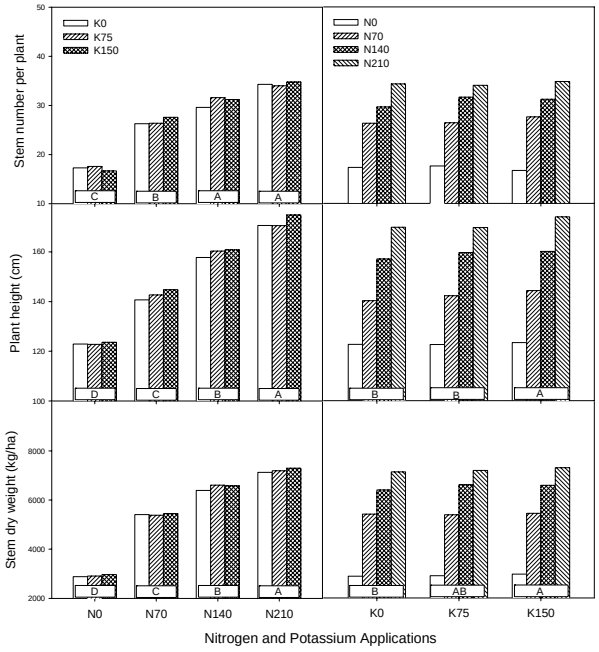


Fig. 2: Effects of different nitrogen (0, 70, 140 & 210 kg/ha) and potassium (0, 75 & 150 kg/ha) applications on stem number of plant, plant height and stem yield of ramie (*Boehmeria nivea*). Capital letters (A, B, C & D) indicates significance levels (P < 0.05)



efficiency (Gething, 1993), highest plant height (174.8 cm) obtained from highest application of K combination with highest N dose used in the current study. Positive effects of N and K fertilization on stem dry weight were found in ramie plants (Fig. 2). Highest stem dry weight (7.3 ton/ha) recorded in treatments where 210 and 150 kg ha^{-1} of N and K were applied. Since stem is most important plant part in ramie for fiber production, partitioning of dry matter to stem as a result of different fertilization application needs to be emphasized. Our results show that highest N application caused greatest dry matter production in stem. However, detailed investigations needs to be done, whether increment in stem dry matter can be obtained by higher amount of N

Table I: Effects of different nitrogen (0, 70, 140 & 210 kg/ha) and potassium (0, 75 & 150 kg/ha) applications on fiber yield and quality of ramie (*Boehmeria nivea*)

		Crude fiber yield (kg/ha)		Fiber yield (kg/ha)		Fiber length (mm)		Fiber fineness (micron)		Fiber strength (pressley)	
	K_0	889		637		63.7		39.9		194.2	
N_0	K_{75}	891	892 d	632	639 d	59.8	62.3	42.6	41.5	198.1	198.3
	K_{150}	896		639		63.3		41.9		202.5	
	K_0	1674		1185		64.0		42.5		196.0	
N_{70}	K_{75}	1653	1664 c	1162	1176 c	67.6	64.8	40.8	42.0	197.9	197.9
	K_{150}	1664		1181		62.9		42.6		199.7	
	K_0	1964		1387		66.1		41.9		194.7	
N_{140}	K_{75}	2021	2000 b	1412	1406 b	65.2	65.7	43.0	42.1	200.2	199.2
	K_{150}	2015		1419		65.8		41.4		202.7	
	K_0	2166		1513		65.3		41.8		195.6	
N_{210}	K_{75}	2180	2187 a	1533	1519 a	66.1	65.2	41.9	41.6	199.4	198.6
	K_{150}	2207		1511		64.3		41.2		200.8	
	K_0	1673		1181		64.8		41.5		195.1 b	
Mean	K_{75}	1688		1185		64.7		42.1		198.9 a	
	K_{150}	1695		1187		64.1		41.8		201.4 a	
		MSE: 3343.9		MSE: 1058.9		MSE: 21.381		MSE: 11.713		MSE: 8.382	
	LSD	N: 133.25		N: 96.75						K: 3.427	

MSE= Mean Squire Error

than 210 kg ha^{-1} treatment. Stem dry weight did not appreciably differ by K75 and K150 (Fig. 2). Therefore, K7.5 treatment can be suggested as K fertilization with the highest amount of N application to obtain higher stem dry matter.

Crude fiber yield of plants increased with higher N applications (Table I). Highest amount (2187 kg/ha) recorded in N210 treatment. However, different levels of K fertilization did not affect crude fiber yield. Significant differences were also found in fiber yield of plants between N treatments, whereas K has no effect (Table I). Concomitant increase was observed in stem yield (Fig. 2) and fiber formation (Table I) in plant by successive application of N. However, K improved stem yield, while it has not effect on fiber yield. Conversely, Liu *et al*. (2000) reported that K concentration of stem wood was higher than other parts of ramie plants and they attributed that K has positive and significant correlation with fiber yield of plant. Although fiber length (59.8-66.1 mm) and fineness (39.9-43.0 micron) were not affected by N and K fertilization, strength of fiber obtained from ramie plants improved by K application (Table I). Higher fiber strength was found in K75 (198.9 pressley) and K150 (201.4 pressley) treatments, while the lowest amount obtained from K0 (195.1 pressley). There was no statistically significant difference between K75 and K150 treatments. Although K did not result in discernible change on fiber yield, fiber strength as one of the most important quality parameters appreciably affected. Pervez *et al*. (2005) suggested that main contributors of osmotic potential of fiber cell are K and malate, which accumulate in the fiber. It was also found that turgor pressure, which stimulates fiber extension is controlled by K^+-malate osmoregulation system (Dhindsa *et al*., 1975). Our results suggested that growth and fiber yield of plants mostly influenced by N fertilization, whereas K fertilization was more pronounced for fiber quality. However, Macarayan (2005) found positive effect of N application after each harvest (three times in a year) on fiber quality of ramie plant as well. This conclusion implies effects of N fertilization on quality may also change by application time.

The present study outlined specific effects of N and K fertilization on yield and fiber quality of ramie. Our findings tend to demonstrate that plant growth, dry matter formation in stem and fiber yield mostly affected by N, whereas higher amount of K contribute to fiber strength and quality. Further investigations are thus still required to understand response of ramie to mineral fertilization.

Acknowledgements: The authors express many thanks to Ege University, Izmir, Turkey for the financial support to this study.

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(Received 30 October 2009; Accepted 31 December 2009)