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Original Article

Effect of NPK and KNO_3 fertilizer on yield and quality of Madura tobacco Prancak N1

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Abstract

Madura tobacco Prancak N1 is a new superior variety with higher quality but lower nicotine content than Prancak 95 tobacco variety. The rate and form of fertilizer for the new variety has not yet been defined so that farmers have to use adding nitrogen fertilizer their tobacco with no phosphorus and potassium fertilizer. The objective of the research was to determine effect of NPK and KNO_3 fertilizers on yield and quality of Madura tobacco var. Prancak N1. The research was carried out at Cen-lecen village, Pakong Sub District of Pamekasan District, Madura. The experiment was laid out in a randomized block design with three replication of each plot. Treatments consisted of 9 packs of fertilization with NPK compound fertilizer (8-15-19), and KNO_3 (13-0-45) and those were compared with 1 packed of recommended using single fertilizer of 40 kg N-ZA + 36 kg P_2O_5-SP36 + 25 kg K_2O-ZK + 5 ton organic manure per hectare. Results showed that addition of compound fertilizers NPK plus KNO_3 increased absorption of macro nutrients NPK, yield and quality of madura tobacco Prancak N1 variety. Package fertilizers NPK plus KNO3 with the rate of 40 kg N + 36 kg P_2O_5 + 61 K_2O per hectare was suggested for madura tobacco Prancak N1 variety to produce high yield (846 kg/ha), grade index value (87.4), and crop index value (73.9).

Keywords: KNO_3, madura tobacco Prancak N1, NPK fertilizer

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Introduction

In Madura, tobacco is one of the important commercial crops, cultivated mostly as rain fed crop in the transitional tract covering an area of 60,000 ha in three districts of Pamekasan, Sumenep and Sampang. The tobacco is mostly planted in dry land and dry climate where the agro-ecology is suitable for producing semi aromatic tobacco. Akehurst (1981) classified madura tobacco as a semi aromatic tobacco.

The new superior varieties has been released by Indonesia Ministry of Agriculture and registered as Prancak N1 and Prancak N 2. The two varieties have lower nicotine content than Prancak 95 (conventional variety), but they have higher quality index and crop index values as presented in Table 1 (Suhara, 2012).

In 2012, the two tobacco superior varieties were planted in Sumenep district with the acreage of 3,200 Ha. However there is no information about the response of those varieties to addition of NPK fertilizer. Until now, recommended fertilizer for tobacco planted in dry land is 200 kg ZA + 100 kg SP 36 + 50 kg ZK + 2.5 ton manure, and for tobacco in irrigation is 300 kg ZA (Rachman & Murdiyati, 1987).

Table 1. Characteristics of Prancak N-1 and Prancak N-2 madura tobacco varieties.

Variety	Productivity (ton/ha)	Grade Index	Crop Index	Nicotine (%)
Prancak N1	0.9	62.45	60.07	1.76
Prancak N2	0.8	68.52	56.07	2.00
Prancak-95	0.8	57.12	45.22	2.31

Source: Balittas, 2012

Balanced nitrogen, phosphorus and potassium fertilization is a key practice towards improved profitability and productivity of tobacco and sustained soil productivity (Murugappan, 2007). The objective of the research was to quantify the effect of NPK fertilizer on yield and quality of the new superior varieties of madura tobacco, Prancak N1.

Methods

Field experiment was conducted from April up to December 2015 at village of Cen-Lecen, sub-district of Pakong, and District of Pamekasan, East Java. The soil texture of the experimental site is silty loam with very low soil C organic content, low total nitrogen and available potassium (Tab. 2).

The experiment was laid out in a randomized block design with three replicates. Treatments consisted of 9 packs of fertilization with NPK compound fertilizer (8-15-19) and KNO_3 (13-0-45) and those were compared with 1 packed of tobacco recommended fertilization 40 kg N + 36 kg P_2O_5 + 25 kg K_2O + 5 ton organic manure per hectare (Tab. 3). Tobacco madura var. Prancak N1 was planted in double row with spaced at (80+40)/2 cm x 35 cm.

Observation was done on parameters of size of leaves (bottom, middle and top leaves), fresh leave yield, dried leaves yield, grade index and crop index. Size of bottom,

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middle and top leaves measured were 6th, 9th and 13th leaves. In each treatment 10 plants were selected randomly for measuring leave size.

Grade Index (GI) was calculated with formula:

$$GI = \frac{\sum_{i=1}^{n} (PIi \times Wi)}{\sum_{i=1}^{n} Wi}$$

PI = Price Index, W = weight of sliced tobacco

Value of Crop Index (CI) was determine by using formula: CI = GI x Y/100, Y = yield (kg/ha).

Table 2. Characteristics of soil experiment site.

Soil characteristics	Value	Categories
pH 1:1		
- H_2O	6.6	Neutral
- KCl 1N	6.3	
C Organic (%)	0.94	Very low
N total (%)	0.10	Low
C/N	10	Low
P_2O_5 Olsen ($mg.kg^{-1}$)	16.06	High
K NH_4OAC1N pH:7 (me/100g)	0.15	Low
Na NH_4OAC1N pH:7 (me/100g)	0.24	Low
Ca NH_4OAC1N pH:7 (me/100g)	21.61	Very high
Mg NH_4OAC1N pH:7 (me/100g)	1.54	Medium
KTK NH_4OAC1N pH:7 (me/100g)	24.12	
Total of Base (me/100g)	23.55	Low
Base Saturation	98	Very high
Cl ($mg.kg^{-1}$)	216	Medium
Texture		
- Sand (%)	27	Silty loam
- Silt (%)	62	
- Clay (%)	11	

Table 3. Source and rates of NPK fertilizer.

No	Source of fertilizer (kg/ha)						Rate (kg/ha)		
	NPK 8-15-19	KNO_3	ZA	SP36	ZK	Manure	N	P_2O_5	K_2O
1.	-	-	200	100	50	5000	40	36	25.0
2.	100	-	160	-	-	5000	40	15	19.0
3.	200	50	87.5	-	-	5000	40	36	60.5
4.	300	100	15	-	-	5000	40	45	102.0
5.	100	-	260	-	-	5000	60	15	19.0
6.	200	50	187.5	-	-	5000	60	36	60.5
7.	300	100	115	-	-	5000	60	45	102.0
8.	100	-	360	-	-	5000	80	15	19.0
9.	200	50	187.5	-	-	5000	80	36	60.5
10.	300	100	215	-	-	5000	80	45	102.0

Table 4. Effect of treatments on leaf size of Prancak N1 Madura tobacco variety.

Treatment	6th Leaf-6 (cm)		9th Leaf- (cm)		13th Leaf- (cm)	
	Length	Width	Length	Width	length	Width
$N_{40}P_{36}K_{25}$ *)	37.8 b**	24.4 b	36.6 d	22.0 cd	25.8 b	14.1 b
$N_{40}P_{15}K_{19}$	37.2 b	23.9 b	36.0 d	21.8 d	25.8 b	14.4 ab
$N_{40}P_{36}K_{61}$	38.7 ab	25.5 ab	38.2 bcd	22.5 bcd	27.2 ab	15.0 ab
$N_{40}P_{45}K_{102}$	39.3 ab	25.4 ab	37.1 cd	22.0 cd	26.1 b	14.4 ab
$N_{60}P_{15}K_{19}$	38.1 b	24.3 b	36.7 d	21.9 d	27.4 ab	15.5 ab
$N_{60}P_{36}K_{61}$	39.7 ab	25.3 ab	38.5 bcd	23.1 bcd	26.9 ab	14.8 ab
$N_{60}P_{45}K_{102}$	40.0 ab	26.0 ab	40.5 ab	23.7 bcd	28.3 ab	15.5 ab
$N_{80}P_{15}K_{19}$	38.3 b	24.6 b	37.4 bcd	22.5 bcd	27.4 ab	15.9 ab
$N_{80}P_{36}K_{61}$	39.6 ab	24.9 ab	39.9 abc	23.9 ab	29.5 ab	16.4 a
$N_{80}P_{45}K_{102}$	41.8 a	27.0 a	41.8 a	24.9 a	30.2 a	16.4 a

**) Control treatment*

***) Number at the same column followed by the same letter are not significantly different at p <0.05*

Results

Leaf Size

Based on statistical analysis it was known that treatment of fertilizer had a significant on leave size of N1 variety of madura tobacco. In general, increasing the rates of NPK fertilizer increased the size of tobacco leaves. The largest size of bottom, middle and top leafs was found at the tobacco treated with $N_{80}P_{45}K_{102}$ or tobacco that was added with 80 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare (Tab. 4). Compare to control treatment ($N_{40}P_{36}K_{25}$), addition of 80 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare increased length of bottom, middle and top leaves about 11, 14 and 17% respectively. Bottom, middle, and top leaves of tobacco with addition of 80 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare were wider than those of control treatment. However treatment of fertilizer $N_{40}P_{36}K_{61}$ was not significant different with $N_{80}P_{45}K_{102}$ treatment on their effect on bottom and top leaves size. The significant effect of fertilizer treatment on leaves size of the N1 variety tobacco was related to the low content soil of C organic, N total and K (Tab. 2).

Yield, Grade Index and Crop Index of Tobacco

Fertilizer treatment had a significant effect on yield, grade index, and crop index of Prancak N1 tobacco variety. Different effect of each treatment on yield, grade index, and crop index of the tobacco is presented in Table 5.

The highest yield of tobacco (7,126 kg fresh yield and 979 kg dried yield per hectare) was ($N_{80}P_{45}K_{102}$). Oppositely, the least of tobacco yield was produced by tobacco added with control treatment ($N_{40}P_{36}K_{25}$ or 40 kg N + 36 kg P_2O_5 + 25 K_2O per hectare). Compared to the control treatment, fertilizer package of 80 kg N + 45 kg P_2O_5 + 102 K_2O per hectare resulted in higher tobacco fresh and dried yields, 59.88% and 59.97% respectively. However the highest fresh yield was not significantly different with those of tobacco added with less P and less K_2O (80 kg N + 15 kg P_2O_5 + 19 K_2O and 80 kg N + 36 kg P_2O_5 + 61 K_2O per hectare). Also, the highest dried tobacco yield was not significantly different with those of tobacco added with less N, P and K_2O (40 kg N + 36 kg P_2O_5 + 61 K_2O per hectare).

Table 5. Effect of fertilizer treament on yield, grade index, and crop index of Prancak N1 Madura tobacco variety.

Treatment	Fresh yield (kg/ha)	Dried yield (kg/ha)	Grade Index	Crop Index
$N_{40}P_{36}K_{25}$ *)	4,457 c **)	612 d	85.6 ab	52.5 c
$N_{40}P_{15}K_{19}$	4,772 bc	743 bcd	86.5 a	64.5 abc
$N_{40}P_{36}K_{61}$	5,426 bc	846 abc	87.4 a	73.9 a
$N_{40}P_{45}K_{102}$	5,051 bc	842 abc	87.6 a	73.8 a
$N_{60}P_{15}K_{19}$	4,790 bc	721 bcd	82.6 ab	59.6 abc
$N_{60}P_{36}K_{61}$	6,140 ab	866 ab	81.9 ab	71.0 ab
$N_{60}P_{45}K_{102}$	5,462 bc	705 cd	81.5 ab	57.5 bc
$N_{80}P_{15}K_{19}$	5,974 abc	748 bcd	77.0 ab	57.1 bc
$N_{80}P_{36}K_{61}$	6,047 abc	734 bcd	74.9 b	55.6 c
$N_{80}P_{45}K_{102}$	7,126 a	979 a	74.7 b	73.2 a

**) Control treatment*
***) Number at the same column followed by the same letter are not significantly different at p <0.05*

Table 6. Effect of fertilizer treatment on nutrients absorption of Prancak N1 Madura tobacco variety.

No	Treatment	Nutrients absorption (kg/ha)		
		N	P	K
1.	$N_{40}P_{36}K_{25}$ *)	13.2 d	0.9 b	4.8 c
2.	$N_{40}P_{15}K_{19}$	15.0 cd	1.1 ab	4.1 c
3.	$N_{40}P_{36}K_{61}$	17.5 abcd	1.1 ab	7.4 b
4.	$N_{40}P_{45}K_{102}$	14.7 d	1.1 ab	7.7 b
5.	$N_{60}P_{15}K_{19}$	18.1 abcd	0.9 b	4.8 c
6.	$N_{60}P_{36}K_{61}$	22.5 ab	1.1 ab	8.3 b
7.	$N_{60}P_{45}K_{102}$	15.4 bcd	0.9 b	6.8 b
8.	$N_{80}P_{15}K_{19}$	22.1 abcd	0.9 b	3.9 c
9.	$N_{80}P_{36}K_{61}$	20.1 abcd	0.9 b	7.3 b
10.	$N_{80}P_{45}K_{102}$	24.3 a	1.3 a	11.8 a

**) Control treatment*
***) Number at the same column followed by the same letter are not significantly different at p <0.05*

In general at the same rate of P and K fertilizer, high grade index value of Madura tobacco var N1 (more than 81) was produced by tobacco which was added with 40 and 60 kg N/ha. The rate of 80 kg N/ha yielded tobacco with lower grade with value 74-77. It seems likely that for producing good quality, Prancak N1 variety required N fertilizer with the rate of 40 – 60 kg N per hectare. It was also expressed by crop index value (index of tobacco price value) that the highest crop index value was produced by tobacco with addition of 40 kg N plus 36 kg P_2O_5 and 61 kg K_2O per hectare (Tab. 5).

N, P and K Nutrients Absorption

Different forms and rates of fertilizers gave different effect on absorption of macronutrients NPK of Prancak N1 tobacco. In general, tobacco which was fertilized with compound fertilizer NPK plus KNO_3 (treatment no 2 up to 10) absorbed more NPK nutrients than tobacco which was added with single form of fertilizer (control treatment). Increasing rate of NPK fertilizer alleviated the absorption of NPK macronutrients (Tab. 6). Consequently, the highest NPK nutrients absorption was found in Prancak N1 tobacco which was added with the highest rate of NPK fertilizer (80 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare).

Contents of Sugar, Nicotine, and Cl of Tobacco Leaf

Contents of sugar, nicotine, and Cl of Prancak N1 madura tobacco leaves were significantly affected by fertilizer treatments. The different effect of NPK fertilizer on sugar, nicotine and Cl contents of Prancak N1 tobacco is presented in Table 7. In general, increasing the rate of N fertilizer will be followed by increasing sugar content. The highest sugar content (9.2%) of Prancak N1 Madura tobacco was found in tobacco leaves that received 40 kg N + 36 kg P_2O_5 + 61 kg K_2O per hectare ($N_{40}P_{36}K_{61}$). The sugar content was significantly different with that of tobacco leaves added with 80 kg N per hectare. Oppositely, increasing the rate of N fertilizer significantly increased nicotine content of the tobacco.

Cl content of the tobacco leaf was affected by NPK fertilizer. The highest Cl content (1.98%) was found at the tobacco added with control treatment (40 kg N + 36 kg P_2O_5 + 25 kg K_2O per hectare). The lowest Cl content (1.40%) was identified at the sample leafs of tobacco added with 40 kg N + 15 kg P_2O_5 + 19 kg K_2O per hectare. However, the Cl content is still higher than 1% (the maximum Cl content for tobacco).

Table 7. Effect of fertilizer treament on sugar, nicotine, and Cl contents of Prancak N1 Madura tobacco variety.

No	Treatment	Nicotine (%)	Sugar (%)	Cl (%)
1.	$N_{40}P_{36}K_{25}$ *)	2.2 abc	7.6 abc	2.0 a
2.	$N_{40}P_{15}K_{19}$	2.2 abc	6.4 abcd	1.4 b
3.	$N_{40}P_{36}K_{61}$	2.0 bc	9.2 a	1.8 ab
4.	$N_{40}P_{45}K_{102}$	1.7 c	8.4 ab	1.7 ab
5.	$N_{60}P_{15}K_{19}$	2.2 abc	7.6 abc	1.9 ab
6.	$N_{60}P_{36}K_{61}$	2.6 ab	6.4 abcd	1.6 ab
7.	$N_{60}P_{45}K_{102}$	2.4 abc	8.4 ab	1.7 ab
8.	$N_{80}P_{15}K_{19}$	2.8 a	4.0 d	1.5 ab
9.	$N_{80}P_{36}K_{61}$	2.5 abc	4.8 cd	1.9 ab
10.	$N_{80}P_{45}K_{102}$	2.7 ab	5.6 bcd	1.7 ab

**) Control treatment*
***) Number at the same column followed by the same letter are not significantly different at p <0.05*

Discussion

NPK fertilizer has macronutrients that have important role on growth, yield and quality of tobacco. A lot of factors influence the efficacy of NPK fertilizer on tobacco, such as nutrients status in soil, fertilizer rates and forms, and tobacco variety (Tso, 1972; Ceotto & Castelli, 2002). In this study, the soil of experiment had low content of N and K but it had high content of P. Addition of NPK fertilizer rate had increased absorption of NPK nutrients which resulted in increasing of growth and yield of Prancak N1 tobacco variety. The highest leaves size (length and width) and yield of the tobacco were from plots that added with the highest rate of NPK fertilizer (80 kg N + 45 kg P_2O5 + 102 K_2O per hectare). It might be similar to results on Prancak Agribun T1 madura tobacco variety which was noted by Sholeh et al. (2016) that increased rate of NK fertilizer up to 50 kg N and 80 kg K_2O per hectare had significant effect on increasing leave seize and yield of the tobacco. For Virginia tobacco, Kumar et al. (2013) reported that increasing NK compound fertilizer up to 60 kg N and 120 kg K_2O per hectare increased yield and quality of the tobacco. However, NPK fertilizer with the rate of 40 kg N + 36 kg P_2O_5 + 61 kg K_2O per hectare was suitable to give high yield and crop index of madura tobacco Prancak N1 because the treatment was not significantly different with the highest rate of NPK fertilizer on their effect on yield and crop index values (Tab. 5). Compared to control treatment which was consisted of single fertilizer (ZA + SP36 + ZK or $N_{40}P_{36}K_{25}$ treatment), compound fertilizer NPK with the rate of 40 kg N + 36 kg P_2O_5 + 61 kg K_2O per hectare increased dried yield and crop index as much as 38.24 % and 40.76% respectively (Tab. 5).

It seems likely that the rate of NPK fertilizer for Prancak N 1 variety is less than that for Prancak 95 to produce high yield and crop index value. The proper rate of NPK fertilizer for Prancak 95 was 60 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare (Syaputra & Djajadi, 2018). But this study found that the rate of the NPK fertilizer for Prancak N1 was only 40 kg N + 36 kg P_2O_5 + 61 kg K_2O per hectare. It might be related to characteristics of Prancak N1 which has a lower nicotine content than Prancak 95. Prancak N 1 is the new variety which produced by croos breeding between Prancak 95 variety and Ismir variety. Izmir is oriental tobacco which has small, aromatic and elastic leaves (Altria, 2018).

The highest absorption of N, P and K nutrients was found in Prancak N1 madura tobacco with highest rates of NPK fertilizer (80 kg N + 45 kg P_2O5 + 102 kg K_2O per hectare) as it was presented in Table 5. Soil of this

research has low content of N and K nutrients, so that the more rates of NPK fertilizer added the more amounts of the nutrients were absorbed by the tobacco. N and K are the most important nutrients for the production and quality of flue-cured virginia tobacco which inflence on tobacco qualities such as flavor, color, texture, sugar and nicotine contents, flammability, and smoke flavor (Smith, 2009; Lu et al., 2005; Marchetti et al., 2006; Gurumurthy & Vageesh, 2007; Hoyos et al., 2015)

Many studies reported that there were correlation between the leaf chemical composition and the quality of tobacco (Song et al., 2007; Hou-long et al., 2016; Bailey, 2014; Gršić et al., 2014). Nicotine, total sugars, and Cl contents are the important parameters for cigarette industries to control the chemistry of crop yield. Karaivazoglou et al. (2007) and Haghighi et al. (2011) found that leaf nicotine content was significantly affected by N fertilization. In general, this study showed that nitrogen rates had significant effect on nicotine content of Prancak N1 tobacco leaf (Tab. 7). Increasing the rate of N fertilizer increased nicotine content of the tobacco leaf due to nicotine is made from nitrogen (Tso, 1990). High nicotine contents (>2.5%) were found in tobacco with added 80 kg N/ha. This study also found that application high N fertilizer rate decreased sugar content. Similar results was also obtained by Amirhandeh et al. (2012) who reported that increasing of N uptake by tobacco was followed by increasing nicotine content but decreasing sugar content of tobacco.

In this study application of N-nitrate decreased Cl content of tobacco leaves. Compared to control treatment (40 kg N-Za), addition of 40 kg N-NPK significantly decreased leaves content from 2% to1.4 % (Tab. 7). Cl content in tobacco leaves should be in optimum level, very high or very low content of Cl will affect tobacco quality and the optimum level different among tobacco varieties (Bozhinova, 2012; Darvishzadeh et al., 2011). The optimum Cl level of cured tobacco is 0.3%-0.8% (Zeng et al., 2014), and Chari (1995) recommended that the threshold level for Cl content in the tobacco leaves is less than 1.5% because higher amounts of it tends to reduce the burning process. There is no information about the threshold of Cl level of leaves for semi aromatic madura tobacco. In semi aromatic tobacco oriental, Darviszadeh et al. (2011) found that tobacco leave Cl content of 100 genotypes ranged from 0.38 up to 2.68%. The threshold content for Cl in a good and acceptable tobacco leaf is usually less than 1.5% (Chari 1995), and the Cl content more than 2% reduce the burning properties of tobacco (Akehurst, 1981; Guardiola et al., 1987; King, 1990). In this study, madura tobacco Prancak N 1 variety which had high tobacco quality (grade index) was treated with 40 kg N + 45 kg P_2O_5 + 102 kg K_2O per hectare and it produced tobacco with Cl leaves content of 1.7%.

Addition of NPK fertilizer plus KNO_3 had significant effect on growth, yield and quality of madura tobacco Prancak N 1 variety. Fertilizer rate for Prancak N 1 variety was 40 kg N + 36 kg P_2O_5 + 60.5 kg K_2O per hectare. Application of the fertilizer rate to madura tobacco Prancak N1 was efficient to produce 900 kg dried leave per hectare, grade index 87.4, and cop index 73.9.

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