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RESPONSE OF SESAME PROMISING LINES (*Sesamum indicum* L.) TO NITROGEN IN IRRIGATED WETLAND AFTER PADDY

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ABSTRACT

An experiment on sesame was conducted in Nganjuk in 2005 to study the response of sesame promising lines to nitrogen in irrigated wetland after paddy. The experiment was arranged in factorial randomized block design with two factors and three replications. The first factor were two sesame lines (Si.25, Si.28) and Sbr.1 variety as control, whereas the second were five N dosage (0; 22.5; 45; 67.5 and 90 kg N/ha). Result showed that sesame in irrigated land after paddy was response to N. The respective optimum N dosages for irrigated wetland after paddy were: 83.34 kg/ha for Si.28, and 42.20 kg/ha for Sbr.1. The best N dosage for Si.25 was 22.5 kg N/ha. The superior line for irrigated land after paddy is Si.28.

Keywords: Sesame (*Sesamum indicum* L.), nitrogen, irrigated wetland after paddy

INTRODUCTION

Sesame seed contains 35-60% oil, 19-25% protein, 7-8% fiber, ash and water, so it can be used for various industrial and edible oils. Sesame oil contains anti-oxidants, sesamin, and sesamolin, so it can be stored long-lasting (Ram *et al.,*1990; Suddhiyam and Maneekhao, 1997; Oplinger *et al.*, 1997, Katzer, 1999; Anonymous, 2007a; Anonymous 2007b; Anonymous, 2007c).

Formerly, Indonesia was exporters of sesame seeds, but due to declining production since 2008 and increasing sesame consumption demand, nowadays Indonesia became importers (Anonymous, 1990). Sesame imports in 1998 amounted to 940.450 tons and 133.729 tons of oil seeds (Anonymous, 1998), in the year 2001 increased to 3722.472 tons and 218.081 tons of oil seeds (Anonymous, 2001).

Farmers have cultivated sesame, because it suitable for many soil types, cultivation is relatively easy, small failure risk, low-input and easily intercropped with food crops. Farmers use local varieties with low productivity levels of cultivation techniques, so the productivity of sesame farmers are still very low (400 kg/ha).

The opportunities to increase domestic production of sesame is still quite large, including in lowland after paddy (MK-II) that more and more devotees are like in Nganjuk, Sragen, Demak, and Sukoharjo. However, cultivation practices in wetland after paddy in dry season only implement of technique for dry land in rainy season, that is inappropriate. Productivity can be enhanced by the use of improved varieties suitable for paddy fields after rice (MK-II) with an appropriate cultivation technique, including fertilization. Sesame breeding program in Indonesian Tobacco and Fiber Crops Research Institute (IToFCRI / BALITTAS) had been produced three superior promising lines (Si. 24, Si. 25, and Si.28) with productivity reaching 1.2 to 1.4 ton/ha. All those lines are better than Sbr.1 variety which had been released, it was also resistant to stem rot disease.

Weiss (1971) reported that nitrogen is transported in the sesame harvest was 120 kg N/ha of a total of 10 112 kg dry matter/ha. To meet the nutrient which is transported along with the harvest, fertilization is needed. However, Beech (1981) reported that added excessive of N causes of thin cell walls seeds that exceed the size of normal cells, thus decreasing the quality of seeds.

Some studies have shown that sesame fertilization is a responsive to the nitrogen

fertilization, depending on variety and environmental conditions including soil fertility. N fertilization up to 45 kg/ha can increase yield by 15% from 1170 to 1345 kg/ha (Machfud *et al*., 1996), but if the dosage of N was increased to 90 kg N/ha, it did not provide significant effect. In the Pasirian Experiment Garden, Kadarwati *et al.* (1994) reported that N fertilizer of 45 kg N/ha in furrow can produce of 999 kg/ha by Sesamindo line. Increasing dosages above 45 kg N/ha was still able to increase yield of sesame but not efficiently. While in India, Desai and Goyal (1981) reported that N fertilization up to 50 kg/ha with a local variety can produce 1000 kg/ha.

This research aims to study the response of several promising lines of sesame that prepared for development in wetland after paddy to N fertilizer and obtain the optimum dosage of N fertilizer to sesame in lowland after paddy (MK-II).

MATERIALS AND METHODS

The study was conducted at centers of sesame development in wetland areas after paddy in the dry season 2005 (MK-II) in Sukorejo village, subdistrict of Loceret, Nganjuk regency. The soil of the area has the following characteristics: pH (H_2O) 7.0; pH (KCl) 5.8; 1.01% organic C; 0.14% total N; 25 C to N ratio; 244.57 mg/kg p (Olsen), cation exchange capacity 25.76 me/100g; 0.31, 0.17, 9.42 and 3.30 me/100g of K^+, Na^+, Ca^{2+} and Mg^{2+}, respectively in ammonium acetate 1N pH 7; 51% base saturation, and 25% sand, 41% silt and 34% clay. The experiment was arranged as a factorial in randomized block design with two factors and three replications. The first factor is sesame promising lines and variety i.e.: 1) Si.25, 2) Si.28, and 3) Sbr.1., while the second factor is five dosages of N fertilizer i.e.: 1) 0 kg N/ha, 2) 22.5 kg N/ha, 3) 45 kg N/ha, 4) 67.5 kg N/ha, and 5) 90 kg N/ha, equivalent to 0, 50, 100, 150, and 200 kg urea/ha respectively. As a basal fertilizer use phosphate with a dosage of 50 kg SP36 and potassium fertilizer by 50 kg KCl per hectare. All the dosages of phosphate and potassium fertilizers were given together in the planting hole side. Nitrogen fertilizer is applied two times, a third dosage at 2 weeks after planting and the remainder at 6 weeks after planting by the side of the planting hole.

Plot size was 5.4 m x 7.5 m and spacing was 60 cm x 25 cm (two plants/hole). The distance between plots and replications was 100 cm. Soil was tiled by hoe, made drainage channel at the boundaries of plot/replication. Sesame seeds were planted with five seeds in a hole as deep as three centimeters and then covered. In the third weeks after planting thinned by left the two plants/hole. Weeding done on two and four weeks after planting. Pests were controlled with insecticides. Irrigation was done by plot if soil became dry. Harvest when capsules began yellowing and leaf fall. Harvesting is done by cutting the stem below the first branch, bound, dried, and then seeded.

Observed variables include plant height, number of branches, number of capsules, N concentration petiole at 7 weeks after planting, seed yield and 1000 grain weight of seeds. Data were analyzed range followed by LSD 5%. The optimum dosage of N obtained by regression analysis.

RESULTS AND DISCUSSION

There was no interaction effect of sesame lines and dosage of N fertilizer on plant height, number of branches, number of capsules, and N petiole concentration (Table 1). While the weight of 1000 grain seeds and sesame seeds yield, are the result of interaction between lines and dosages of N fertilizer (Table 2).

There were no differences in plant height and number of branches from the lines tested. This shows that the lines tested were as good as Sbr.1 variety. Number of capsules of Si.25 line was higher than Si.28 line and Sbr.1, that is mean higher productivity. Petiole N concentration showed that the response of Si.25 and Si.28 lines to N fertilization was higher than Sbr.1 variety. Effect of N fertilizer significantly increased plant growth, are similar to the results of research in Egypt (El-Metwally and Abu-Hagaza, 1988), in Pakistan (Zia, 2002; Malik *et al.,* 2003), in India (Tiwari *et al*., 2000; Naugraiya and Jhapatsingh, 2004), and in Iran (Bahrani and Fard, 2005). The best dosage to improve the growth of sesame was 95.2 kg N/ha in Egypt , 80 kg N/ha in Pakistan, 60 kg N/ha in India, and 90 kg N/ha in Iran. However, the data indicate that the dosage of 22.5 kg N/ha was sufficient to achieve the best growth.

Table 1. Effect of sesame promising lines and N dosage on plant height, branches, capsules and N-petiole in irrigated wetland after paddy, Nganjuk.

Treatments	Plant height	Number of branches	Number of capsules	N-petiole
Sesame lines	(cm)			(%)
Si. 25	105.20	4.17	75.80 b	4.93 b
Si. 28	99.17	3.97	66.23 a	4.67 b
Sbr. 1	101.20	4.20	62.19 a	4.33 a
LSD 5%	ns *)	ns	8.77	0.27
N dosage (kg/ha)				
0	83.78 a**)	3.18 a	41.87 a	4.27 a
22.5	107.33 b	4.04 b	71.62 b	4.85 b
45	106.04 b	4.38 b	71.71 b	4.58 ab
67.5	103.69 b	4.58 b	75.84 b	4.73 b
90	108.44 b	4.40 b	79.31 b	4.79 b
LSD 5%	9.54	0.55	11.32	0.35
CV (%)	9.70	13.81	17.23	7.81

Remarks: *) ns= not significant **) Numbers followed by the same letter is not significantly different at LSD 5%

Table 2. Effect of sesame promising lines and N dosage on grain weight and seed yield in irrigated wetland after paddy, Nganjuk.

Treatment Sesame lines x N dosage			1000 grain weight (g)	Seed yield (kg/ha)	
Si. 25	0	kg N/ha	1.77 a*)	600	ab
Si. 25	22.5	kg N/ha	2.31 de	825	cd
Si. 25	45	kg N/ha	2.35 de	812.5	c
Si. 25	67.5	kg N/ha	2.37 def	500	a
Si. 25	90	kg N/ha	2.24 d	787.5	c
Si. 28	0	kg N/ha	1.84 ab	575	ab
Si. 28	22.5	kg N/ha	1.97 bc	787.5	c
Si. 28	45	kg N/ha	2.01 bc	862.5	cde
Si. 28	67.5	kg N/ha	1.96 bc	1125	f
Si. 28	90	kg N/ha	2.05 c	1000	def
Sbr. 1	0	kg N/ha	2.47 efg	500	a
Sbr. 1	22.5	kg N/ha	2.54 fg	700	bc
Sbr. 1	45	kg N/ha	2.58 g	1025	ef
Sbr. 1	67.5	kg N/ha	2.58 g	550	ab
Sbr. 1	90	kg N/ha	2.55 fg	450	ab
LSD 5%			0.18	177.5	
CV (%)			4.87	14.41	

Remarks: *) Numbers followed by the same letter is not significantly different at LSD 5%

Sesame plants grown in paddy fields after rice (MK-II) showed a responded to nitrogen fertilization. Sesame in wetland after paddy during the dry season was very different from the dry land sesame in rainy season. In the wetland after paddy during the dry season, the plant age became shorter, the age of 1 month had entered the generative phase and started flowering. Increased nitrogen fertilization over 22.5 kg N / ha did not show increased growth. Increasing the N dosage did not further increase the growth of sesame plants, it could be caused of the fertilizers residues from rice crops earlier. Best dosages for growth are influenced by location, season and crop rotation.

Nitrogen fertilizer can increase the weight of 1000 grain seeds, however, increasing dosages above 22.5 kg N/ha did not show significant improvement. The weight of 1000 seeds was not only influenced by nitrogen, but

also by other nutrients. Increased nitrogen fertilization above the 22.5 kg N/ha with no increased in other nutrients did not increased the weight of 1000 seeds.

Increasing dosages of N fertilizer also increased sesame seed yield. The highest seed yield (1125 kg/ha) achieved by the Si.28 line with a dosage of 67.5 kg N/ha. This shows that the Si.28 line is response to N fertilization. For the Si.25 line dosage of 22.5 kg N/ha have been sufficient to obtain the highest yield (825 kg/ha), whereas for the Sbr.1 variety fertilization of 45 kg N/ha could reach the highest yield of 1025 kg/ha.

Some results on sesame researches showed a positive response of nitrogen fertilization on sesame plants, where increasing dosages of nitrogen can increase yield of sesame. The results for two seasons in Egypt showed that the highest yield in the first season of 1231 kg seed/ha achieved in 95.2 kg fertilizer N/ha, while in the second season obtained the highest yield 1737 kg seed/ha by fertilization of 107.1 kg N/ha (El-Metwally and Abdu-Hagaza, 1988). Research in India in twice rainy season in dry land showed that the highest sesame yield was on providing 60 kg N/ha and 30 kg S/ha, yielding 702 kg of seed/ha with oil content of 51.34% and 28.30% protein (Tiwari *et al.*, 2000). Research conducted in Pakistan, showed that giving of 80 kg N/ha produced the highest seed yield of 790 kg/ha, the highest 1000 grain seed weight (3.42 g) and the highest oil content (45.88%) (Malik *et al.,* 2003). In Zimbabwe, the increase of nitrogen dosage up to 90 kg N/ha increased seed yield of sesame to 1475 kg/ha, an increase of 33% compared with no N (Mujaya and Yerokun, 2003). In Iran, fertilization of 90 kg N/ha was also obtained the highest seed yield of sesame of 1724 kg/ha and the accumulation of protein increased 25% compared with no N fertilizer (Bahrani and Fard, 2005).

In the wetland after paddy in the dry season the growth of sesame was different from the rainy season in dry land, where plant lifetime became shorter and more quickly entered to the generative phase. If in dry land fertilization 45-90 kg N/ha could achieved the highest yield, then in wetland after paddy could not be increased simply by increasing nitrogen fertilizer. Except of nutrients balance factor, plants could not absorbed all of nitrogen fertilizer. These results indicate the different responses of lines and variety tested for irrigated wetland after paddy.

Sesame research in wetland areas in the dry season for three years in Tamil Nadu, India showed that the application of 40 kg N/ha which given two times (basal fertilizer and 30 days after planting) with the yield of 893 kg/ha is the most economical dosage for sesame cultivation in wetlands during the dry season (Muthusankaranarayanan *et al.*, 2001).

Based on the regression analysis as in Figure 1, 2 and 3, for each promising line can know the optimum dosage of N fertilization to achieve maximum yields. Increasing dosages of N exceeds the optimum dosage will not improve yields, it can even reduce the yields. For Si.25 line (Figure 1) obtained the equation $Y = -0.0247 X^2 + 2.4444 X + 670$ ($R^2 = 0.0284$). The very small R^2 value cannot be used to determine the optimum dosage. However, based on seed yield data (Table 2), can be taken as the best dosage for Si.25 was 22.5 kg N ha with seed yield of 825 kg/ha.

For Si.28 line (Figure 2), with the equation of $Y = -0.0688 X^2 + 11.468 X + 562.86$ ($R^2 = 0.8986$) obtained the optimum dosage of fertilizer N at 83.34 kg/ha with maximum yield of 1040.75 kg/ha. While for Sbr.1 variety (Figure 3), with the equation of $Y = -0.1975 X^2 + 16.667 X + 495$ ($R^2 = 0.6787$) obtained the optimum dosage of N fertilizer at 42.20 kg/ha with a maximum yield of 846.63 kg/ha. From the lines tested, it can be determined the optimum dosage of N fertilizer on average for sesame cultivation in irrigated wetland after paddy (MK-II) was 52.54 kg N/ha (equivalent to 116.76 kg urea/ha) with a maximum seed yield of 843. 73 kg/ha.

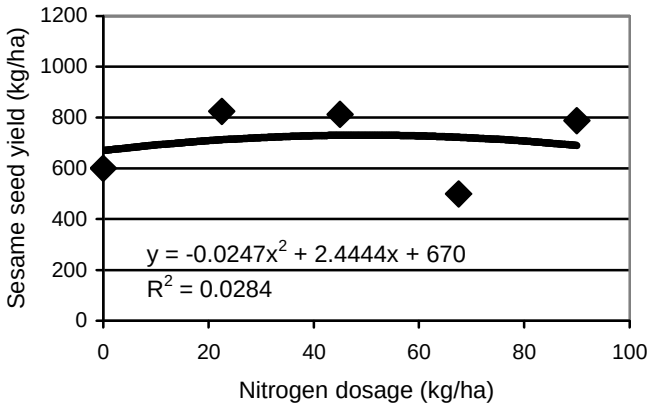

Figure 1. Effect of nitrogen dosage on sesame seed yield of Si.25 line in irrigated wetland after paddy, Nganjuk

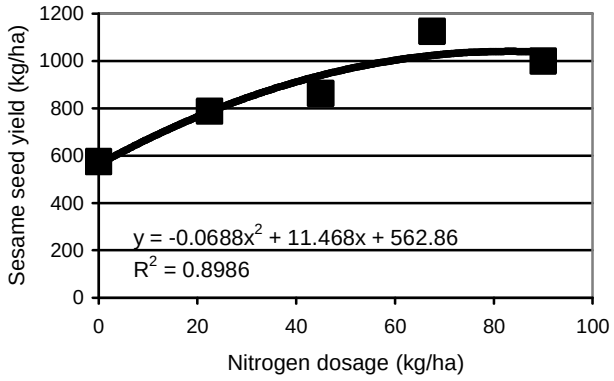

Figure 2. Effect of nitrogen dosage on sesame seed yield of Si.28 line in irrigated wetland after paddy, Nganjuk

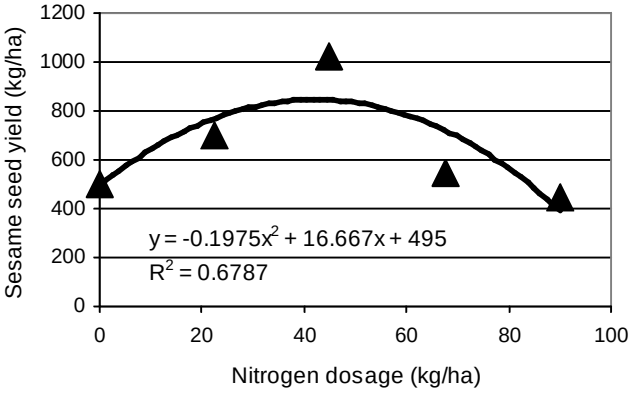

Figure 3. Nitrogen dosage effect on sesame seed yield of Sbr.1 variety in irrigated wetland after paddy, Nganjuk

In irrigated wetland after paddy (MK-II) Si.28 line was superior than Si.25 line and Sbr.1 variety. Results of research in irrigated wetland after paddy (MK-II) showed that Si.28 line very response to N fertilization, increasing dosages of N to optimum level achieve the maximum seed yield. While Si.25 line less response, not obtained the optimum dosage of N fertilizer to achieve maximum yields. If the farmers cultivate sesame in paddy fields (MK-II) with urea input of 100 kg/ha (2 bags), then in one hectare will get yield of 940 kg/ha if use Si.28 line, or 845 kg/ha if using Sbr.1 variety, or an average of 892 kg/ha. So that the sesame plantation development in irrigated wetland after paddy (MK-II) depending on the availability of seeds of varieties that are available. With this advantage, Si.28 line has been proposed to be released as new variety of sesame seed development in irrigated wetland after paddy (MK-II) with the name of Sumberrejo 4 (Sbr.4).

Soil factors also affect the results of fertilization experiments. Research in the alluvial soil of India during the dry season showed that the sesame yield increased 94.2% by adding of 90 kg N/ha (Sarkar and Saha, 2005). Whereas in the sandy clay soil in dry season fertilization with 52.5 kg N/ha, 34.5 kg P/ha and 34.5 kg K/ha could produce sesame of 1488 kg/ha (Kathiresan and Dharmalingam, 1999). In this experiment with clay loam soil, the highest seed yield of 1125 kg/ha was achieved by Si.28 line with a dose of 67.5 kg N/ha, no significantly different from Sbr.1 variety with dose of 45 kg N/ha that achieved seed yield of 1025 kg/ha.

CONCLUSIONS

The Si.28 line and Sbr.1 variety very response to N fertilization, while the Si.25 line less response. The optimum dosages of N fertilizer for the cultivation of sesame in irrigated wetland after paddy (MK-II) were: 83.34 kg N/ha (equivalent to 185 kg urea/ha) for the Si.28 line with maximum yield of 1040.75 kg/ha; and 42.20 kg N/ha (equivalent to 94 kg urea/ha) for Sbr.1 variety with maximum yield of 846.63 kg/ha. While for the Si.25 line not yet obtained the optimum dosage of N fertilizer, but the best dosage of the test was 22.5 kg N/ha (equivalent to 50 kg urea/ha) with seed yield of 825 kg/ha. Si.28 line showed more superior and suitable for development in irrigated wetland after paddy (MK-II).

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