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DO NEW VARIETIES OF MAIZE AND KENAF COULD IMPROVE GROWTH AND PRODUCTION WHEN CULTIVATED BY INTERCROPPING IN SEASONAL FLOODED AREA OF BONOROWO LAND?

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ABSTRACT

Intercropping has an added farming income ratio. Corn as a food source after rice and soybean, is needed by rural communities. This study aims to determine the extent of the production enhancement in the use of maize and kenaf new varieties cultivated using intercropping pattern in seasonal flooded area. Kenaf (*Hibiscus cannabinus* L.) is a natural fiber producing plant able to grow in seasonal flooded area. The intercropping combination of maize and kenaf planting is highly anticipated by farmers. Both commodities are expected to increase farmer revenue/income. The research was conducted in Rowomarto village, Patianrowo sub-district, Nganjuk district in 2015/2016 planting season. The treatments were arranged in a Randomized Block Design that was repeated four times. There were 7 treatments consisting of 3 intercropping of maize and kenaf, and 3 monoculture of kenaf (Kr.9, Kr.11, Kr.12), and 1 monoculture treatment of hybrid corn Bisi 18. Plot size was 9.6 m x 15 m with corn planting distance of 80 cm x 30 cm and kenaf planting distance of 30 cm x 10 cm, one plant per planting hole. The results showed that intercropping of maize and kenaf from the treatment using Bisi 18 hybrid corn + Kr.9; Bisi 18 hybrid corn + kenaf Kr.11; and Bisi 18 hybrid corn + kenaf Kr.12 each gave a farm income ratio of Rp 32.650.000, - / ha Rp. 30,100,000, - / ha and Rp. 30.450.000 / ha respectively. The land equivalent ratio is greater than 1 which means that the area use of intercropping system is efficient.

KEY WORDS

Maize, kenaf, intercropping, flooded area.

Kenaf (*Hibiscus cannabinus* L.) is a fiber-producing plant that can be used as raw material for gunny sack, dash board, door trim, fiber drain, geotextile, pulp and an eco-friendly household handicraft. Marginal land (such as seasonal flooded area) that has not been cultivated as agricultural objects is quite wide, about 4.3 million ha (Puslitanah, 2012). Kenaf is suitable planted in marginal land such as seasonal flooded area or known as bonorowo land. Seasonal flooded area is a land that has an abundant amount of water during rainy season and vice versa the water shrinks during the dry season, even there can be no water at all. In such conditions kenaf is suitable to be cultivated because kenaf has the ability to survive in a flooded area. This happens because kenaf brings out its adventitious roots when there is a puddle. The adventitious root can take O₂ in water, so that the plant photosynthesis process continues even in a waterlogged or flooded conditions.

There are 3 types of seasonal flooded area, namely the seasonal flooded area with very high flooded (flooded reaching > 1 m), seasonal flooded area with medium flooded (flooded reaches 0.5 - 1.00 m) and seasonal flooded area with shallow flooded (flooded reach < 0.50 m). Of the three types of seasonal flooded area, the most ideal to be planted by kenaf are the seasonal flooded area with medium and shallow flooded.

The cropping pattern in seasonal flooded area is planted rice once a year, so the pattern is rice plant – fallow – fallow (Sastrosupadi, 2014). An effort to empower the land is using kenaf planting methods with the hope to eliminate the fallow time that have been happening. In order to support food security, especially corn and fiber availability, the intercropping of maize and kenaf is considered to be a real contribution. In addition, the intercropping pattern of maize and kenaf provides an increase in rural areas farm income. Cultivation using intercropping pattern has benefits, both technically and economically.

Intercropping pattern cultivation means that there is a difference between the use of space, different leaf canopy forms, an unequal rooting system so that both plants can use the environment optimally (Thayamini, et al., 2010). In addition to be more productive land use, the utilization of available natural resources such as water, nutrients, labor and time is more efficient. Economically, it can increase farm income, because it gets double result from two cultivated commodities. According to Arifin et al., (2010), the lack of phosphate elements will cause the plants unable to absorb other nutrients. In general, the phosphate function is as metabolites constituent, activators, cofactors and physiologic.

Plants require a certain amount of potassium from the soil which absorbed in the form of K^+ ions. In soils rich in potassium, the plant is actually able to absorb more than the required amount (Nursyamsi, 2012). Potassium as a catalyst has an important role, especially in the reshuffling of proteins and amino acids. In addition, this element also has the task of dismantling and preparing carbohydrates, so that when the crop lacks of potassium it will inhibit photosynthesis and respiration.

This study aims to determine the extent of production enhancement in the use of maize and kenaf new varieties cultivated using intercropping pattern in seasonal flooded area.

MATERIALS AND METHODS OF RESEARCH

The study was conducted in seasonal flooded area (bonorowo land) precisely in Rawomarto village, Patianrowo subdistrict, Nganjuk district during 2015/2016 planting season. Entisol (Aluvial) is soil type from sedimentary streams in plainly sunken areas (Suprptoahardjo et al., 1960). Climatic type in the experimental area is D3 climate (6-7 month of wet season and 5-6 month dry season) (Oldeman et. al., 1980).

Planting materials used is kenaf new varieties: Kr.9, Kr. 11 and Kr.12 and corns grown is Bisi 18 new varieties. The study was arranged in Randomized Block Design (RAK) where each treatment was repeated four times. There are 7 treatments which consists of: three intercropping of maize and kenaf, three monoculture of kenaf and one monoculture of maize. Plot size was 9.6 m x 15 m. Corn planting distance of 80 cm x 30 cm with one plant per planting hole. The corn is planted first then after it is 15 days old, then continued by planting kenaf. The kenaf planting distance is 30 cm x 10 cm, after grow, it is thinning by leaving 1 plant per hole.

Table 1 – Soil analysis result of Rawomarto area, Patianrowo Nganjuk

Land Characteristic	Value	Categories
pH (H ₂ O)	6,30	Low
KCl	5,20	Slightly acidic
N-total (%)	0,082	Very low
C-total (%)	0,515	Very low
C/N-ratio	6,280	Low
P ₂ O ₅ (Olsen) ppm	11,00	Low
Cation Arrangement (me/100 g)		
K	0,34	Medium
Na	0,90	High
Ca	7,20	Medium
Mg	1,08	Medium
Cation Exchange Capacity (me/100g)	27,32	High
Base saturation (%)	38	Medium
Texture		
Clay	23	Sandy clay
Dust	24	
Sand	53	

Based on NKL Formulation: X_i/Y_i (Hichach and Mecollu, 1987; Rifai et al., 2014), where: X_1 = Intercropping Production, Y_i = Monoculture Production.

Plant maintenance is carried out to control weeds or disturbing plants. In wet season weeds that are commonly encountered are nut sedge, Bermuda grass, reeds and goatweed. The plant maintenance is done manually at the time of weeds grow rapidly around the age of

10-15 days after maize being planted. 6 times water provision during plant growth. Water is obtained from a groundwater source that is pumped by a diesel pump machine. *Helicoverpa armigera* caterpillar pests that attack corn and kenaf are controlled with deltamethrin 0.05-0.1 g/l (2-4 ml Decis 2.5 EC/liter of water). In growth period pests attack is Empoasca sp. or leaf suction pest, this could be controlled using monokrotofos 0.3-0.6 g/l (2-4 ml Gusadrin 154 WSc./liter of water). Stem blight or Fusarium disease should be sprayed with 0.19 g/l Kaarbendazim and mankozeb 2.21 g/l (3 g Delsene 200 MX/liter of water). Inorganic fertilizers administered to kenaf at a dose of 120 kg N + 18 kg P₂O₅ + 30 kg K₂O which equivalent to 300 kg of urea + 50 kg SP 36 + 50 kg KCl per hectare. The fertilizer dose for corn is 80 kg N + 36 kg SP-36 P₂O₅ + 30 kg K₂O which is equivalent to 200 kg Urea + 100 kg SP-36 + + 50 kg KCl/hectare. Fertilization is done by creating a hole near the plant using tugal (ditugal), and then covered with soil.

Parameters observed included plant height, stem diameter and dry fiber yields for kenaf. While for corn the parameters observed included plant height, corn cob and dry corn kernels. It also evaluated farm income and land equivalent ratio. The data from soil analysis at research location are presented in Table 1.

RESULTS AND DISCUSSION

Based on the variance analysis result it is showed that intercropping pattern of corn and kenaf had significant effect on plant height and kenaf stem diameter at 60 days and 120 days after planting (Table 2).

Table 2 – Intercropping effect of maize and kenaf on kenaf plant height growth

Treatment	Kenaf Plant Height, cm	
	Plant age 60 DAP	Plant age 120 DAP
Intercropping Maize and Kenaf		
Kr.9	119,60 a	225,30 a
Kr.11	102,20 a	218,20 a
Kr.12	105,30 a	216,90 a
Monoculture Kenaf		
Kr. 9	190,20 b	310,10 b
Kr.11	187,30 b	301,90 b
Kr. 12	188,30 b	304,20 b

The numbers followed by the same letter in the same column are not significantly different in DRMT test (5%).

The plant height growth for kenaf which intercropped with maize is significantly different compared with monoculture kenaf, either at 60 or 120 days after planting. This occurs because the intercropping pattern of maize and kenaf causes the crop to compete in obtaining nutrients, water, CO₂, spatial and light, so that their growth rate is interrupted. In contrast to the monoculture cropping system, where kenaf plant height growth rate continues to progress without any obstacles. The average height of kenaf plants intercropped using three new varieties that were observed at 120 days after planting was only about 220 cm while the height of monoculture kenaf plants could reach 3.05 cm. According to Santoso et al., (2003) kenaf plant weakness, circular growth is less optimal than the plant height growth. According to Mibar (1997) sunlight as a source of energy for plants play a role in chlorophyll photosynthesis process. Furthermore it was stated that the results obtained from photosynthesis process are carbohydrates that will be distributed throughout the plant organs for growth.

Overall variety analysis data for kenaf stem diameter growth using intercropping pattern is presented in Table 3.

The kenaf stem diameter growth which is intercropped with maize has experience growth restrictions, either at 60 or 120 day after planting. But in monoculture kenaf pattern, the stem diameter growth is not disturbed. This shows that the intercropping pattern of maize and kenaf experiencing a rather tight competition compared with monoculture kenaf pattern.

The variance analysis result shows that hybrid corn Bisi 18 which is intercropped with kenaf has not influence its growth, either height or corn cob length. More data are presented in Table 4.

Table 3 – Intercropping effect of maize and kenaf on kenaf stem diameter growth

Treatment	Kenaf Stem Diameter, mm	
	Age 60 DAP	Age 120 DAP
Intercropping Maize and Kenaf		
Kr.9	119,60 a	225,30 a
Kr.11	102,20 a	218,20 a
Kr.12	105,30 a	216,90 a
Monoculture Kenaf		
Kr.9	190,20 b	310,10 b
Kr.11	187,30 b	301,90 b
Kr.12	188,30 b	304,20 b

The numbers followed by the same letter in the same column are not significantly different in DRMT test (5%).

Table 4 – Intercropping effect of maize and kenaf on P7 hybrid corn growth parameters

Treatment	Maize Height, cm	Cob Length, cm
Intercropping maize and kenaf		
Bisi 18 + Kr.9	272,10 a	19,60 a
Bisi 18 + Kr.11	271,00 a	19,40 a
Bisi 18 + Kr.12	271,60 a	18,90 a
Monoculture maize		
Bisi 18	271,80 a	19,80 a
BNT 5%	0,90	1,10

The numbers followed by the same letter in the same column are not significantly different in BNT test (5%).

Table 5 – Maize and kenaf Intercropping effect on results of dried corn kernels, dried kenaf fiber, farm income and Land Equivalent Ratio

Treatment	Dried Corn Kernels	Dried Kenaf Fiber	Farm Income Ratio	Land Equivalent Ratio
Intercropping maize and kenaf	ton/ha	ton/ha	Rp.	
Bisi 18 + Kr. 9	5,90	2,30	32.950.000	1,80
Bisi 18 + Kr. 11	5,70	2,00	30.100.000	1,64
Bisi 18 +Kr. 12	5,60	2,10	30.450.000	1,66
Monoculture Maize				
Bisi 18	6.10	-	18.300.000	1,00
Monoculture Kenaf				
Kr.9	-	3,50	22.750.000	
Kr.11	-	3,00	19.500.000	
Kr.12	-	3,40	22.100.000	

Description: Price of corn kernels Rp. 3.000, -/kg and the price of quality A dried kenaf fiber Rp, 6,500, -/kg.

Based on the observation parameters above, could be seen that there is no difference between monoculture pattern of maize and intercropping pattern of maize and kenaf in terms of height and cob length. This is due to the maize that planted first before kenaf plant, either using monoculture or intercropping pattern, so that the initial growth rate is not disturbed. Besides, it is suspected that hybrid corn Bisi 18 has a slightly erect leaf shape, that create a more efficient light penetration.

Maize is classified as a C4 plants that has a wide adaptability to growth and yield limiting factors. C4 plant leaves serves as photosynthesis result producer which is then distributed to all parts of the plant. In terms of environmental conditions, C4 plants have the advantages of adapting to various limitations such as lack of light, low rainfall and poor soil fertility (Haryanti et al., 2014)..

Data results of dried corn kernels, dried kenaf fiber, farm income and Land Equivalent Ratio are presented in Table 5.

From table 5 it can be seen that the farming income ratio of intercropping maize and kenaf shows the highest results compared to monoculture either maize or kenaf. So is the Land Equivalent Ratio. This is in line with Adeniyen et al., 2007 research result who argued that the intercropping pattern of maize and kenaf gives the highest LER.

CONCLUSION

From the research can be concluded that intercropping pattern using maize and kenaf new varieties could increase farm income ratio when compared with monoculture system using only maize or kenaf. Farm income ratio of hybrid corn Bisi 18 + kenaf Kr.9; hybrid corn Bisi 18 + kenaf Kr.11; hybrid corn Bisi 18 + kenaf Kr.12, respectively Rp. 32.950.000, - / ha; Rp. 30.100.000, - / ha and Rp. 30.450.000, - / ha. Kenaf highest farm income ratio using monoculture system is obtained from Kr.9 with Rp. 22.750.000, - and an efficient land use with Land Equivalent Ratio is more than 1.

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