Interaction of Fertilizer, Light Intensity and Media on Maize Growth in Semi-Hydroponic System for Feed Production

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ABSTRACT

Corn fodder have great promise as forages that contained high quality and produced in short time. The objective of this research was to study the effect of different fertilizer, light intensity and media on growth pattern, forage yield and quality of corn fodder. Research was conducted at Field Laboratory of Agrostology, Faculty of Animal Science Bogor Agricultural University, in March-April 2017. The fertilizer used were no fertilizer as control, AB mix nutrient (an organic fertilizer) and Subur nutrient (organic fertilizer). The environment factors observed were light intensity, temperature and humidity. The treatment was arranged in Split Plot Design, with three replications. Parameters in this research were plant height, leaves color, root condition, fresh and dry matter yields and forage quality. The result showed that AB mix nutrient application resulted the best plant height, fresh and dry matter yields, and forage quality. The environment factors affected plant height, leaves color and roots condition. It concluded that the best corn fodder production was used an organic fertilizer in sunny day.

Keywords: Corn fodder, Environment condition, plant growth, quality, yield

INTRODUCTION

The increases of livestock population to gain livestock self-sufficient production, resulted large gap in between requirement and availability of feed and fodder. In Indonesia, availability of green fodder is fluctuated due to severe climate change, varied growing time (between 35-60 days), unavailability of enough land, deterioration of fertile soil and water resources competition between fodder and cereal crops (Morsy et al., 2013). Green fodder is an important factor of the livestock ration, especially for ruminant. Limited of green fodder is restricted of feed for animals and its cost increases to reduce livestock losses.

Hydroponically growing fodder isthe transformation of grains into high quality, very lush, highlynutritious, disease free grass and root combination animal feedproduced in a versatile and intensive hydroponic unit (Gebremedin et al., 2015). There is an increasing nutrient profile such as crude protein, ether extract and nitrogen free extract along with improved fresh fodder weight and less fiber content than conventional maizefodder (Gebremedhin, 2015a). Hydroponics is an advanced technology in agriculture which makes agriculture possible everywhere and proven technology adopted across the animal types.

Hydroponic system increased nutrient content of maize fodder such as crude protein, ether extract and nitrogen free extractalong with improved fresh fodder weight and less fibercontent (Gebremedhin, 2015b). Hydroponic fodder was optimize the general health and performance of young animals while minimizing feed costs (Kumalasari and Khotidjah, 2008), increased the digestibility of nutrients of lactating cows and milk production leading to increase in net profit (Naik et al., 2014).Due to the above constraints in the conventional method of

fodder cultivation, hydroponics technology is coming up as an alternative to grow fodder for farm animals (Kumalasari et al., 2009).

Maize (*Zea mays* L.) is grown as dual purposes such as food, feed, and fodder crop in Indonesia. Therefore, the hydroponic growing room that should be a system that has been specifically developed to disregard the external abiotic factors and produce highly nutritious and quality fodder as livestock feed.Farmer need the user friendly hydroponic system that could installed easily in their farm. Hence, this research was conducted to evaluate abiotic factors that affect production and quality of maize fodder in hydroponic system, ie.: fertilizer, media, light and humidity.

MATERIALS AND METHODS

Production of hydroponics maize fodder. The investigation was conducted at Field Laboratory of Agrostology of Department of Nutrition and Feed Technology Faculty of Animal Science of Bogor AgriculturalUniversity. A hydroponic unit was constructed in green house using internalrack structure was with 1 x 1 x 3 m height, width andlength respectively. The internal structurewas equipped with 54 plastic trays having, size of40x30x13 cm height equipped with manual sprayer irrigation.This system was constructed as a semi-intensive using 100% and 50% sun light used shed net, semi-hydroponic using water, husk rice and grilled rice straw as media.In order to manage and control water availability of system, proper watering was carried out twotimes per day manually. Hybrid maize variety (*Zea mays* L.) was used and scarified for 15 minutes in hydrochloride solution. The seed was washed and soaked for 24 hours in tap water. After 24 hours of germination, sprouted seeds were spread on the hydroponic tray at a rate of 250 gram for maize per tray and covered by 1.5-2 cm layer thickness of media for semi-hydroponic system. Inside the green house, for the first period the plants are allowed to grow for 9 days and then on tenth day.The second period the plants are allowed to grow for 7 days and then on eighth day.The yield was fed to the sheep animal for palatability test. Each harvested hydroponic maize fodder were sampled 200 g to determine the nutrient composition and dried under sun light for 3 days then oven dried at 100 °C and ground to pass a 1-mm mesh screen sieve and analyzed nutrients content by proximate analysis i.e. Dry Matter, Crude Protein, Crude Fiber and Total Ash (AOAC, 1988).

The experiment was laid out in split plot design in time with four factors, i.e.: two harvest times (10 and 8 days); media type (water, grilled husk rice and grilled straw rice); fertilizer (water, an organic fertilizer-ABmix, and organic fertilizer-Subur) and shading levels (0% and 50%). Data recorded included on the plant height (cm), temperature (^{o}C/day), humidity (%/day), yield production (g/plot), and nutrient composition.

Statistic. Statistical models were fitted by regression analysis, using Linear Model (LM) procedure of R ×64 3.0.2 software (R Development Core Team, Vienna, 2013) using the 'Rcmdr' and 'library CAR' packages. Furthermore, the model were tested using Component Residual Plots and Effect Plot to determine environment effect.

RESULTS AND DISCUSSION

Effect of environment on plant growth

Environment factors such as light (Promatrak, 2017), temperature and soil (Sakamoto and Suzuki, 2015) affected on plant growth. On average, environment condition in the first research period (10 days) and the second (8 days) was different. In the first period, there was

a lot of rain a long of investigated days that affected on temperature and humidity (Figure 1) and light intensity (Figure 2), respectively.

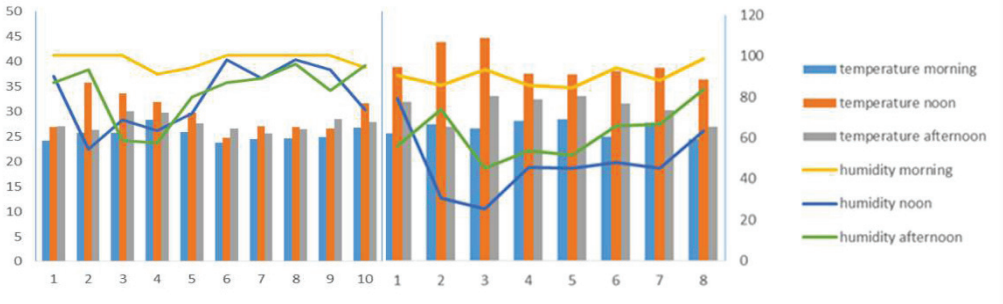


Figure 1. Temperature and humidity on research period 10th and 8th day

The change of environment condition affected on greenhouse condition, especially on rainy days and daily time. The investigation included temperature, humidity and light intensity in morning (08.00-08.30), noon (12.00-12.30) and afternoon (16.00-16.30). In the rainy day, there was low light intensity and temperature, while humidity on greenhouse was increased. In the sunny day, light intensity and temperature was increased rather humidity was decreased, contrarily.

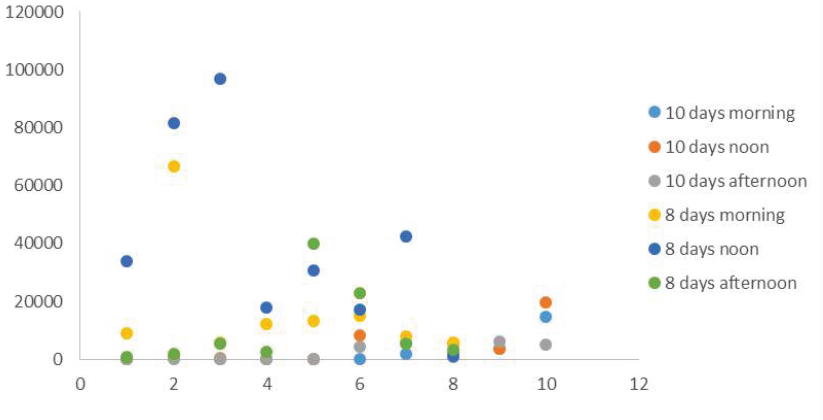


Figure 2. Light intensity on research period 10th and 8th day

The plant height of green maizewas measured from plant butt to the end of leaves. Maize plant height was significantly increased by age, media and fertilizer Table 1. Plant age was significantly affected on the average plant height (13.87 ± 2.07 cm) achieved on 8th and 10th day age (20.89 ± 2.87 cm). Maize height was increased because the growth pattern of plant in linear curve until 30 days after sowing, then sigmoid growth curve was formed (Soro *et al*, 2015).

At 10 days of growth period 250 g of maize was produced 15.44-28.33 cm average plant height, while on 8 days period reached 9.67-21.2 cm average plant height. The results of 8th day was under the results reported by Naik et al. (2013) and Gebremedhine (2015a) in maize hydroponic fodder as 20–30 cm, whether 10th plant height in line with it. These low of plant height might resulted by plant genetic of local maize (Gebremedhine, 2015b).

Table 1. Statistical analysis of environment factor on plant height

	Sum Sq	Df	F value	Pr(>F)
age	178.500	1	52.6444	3.071e-10 ***
humidity	0			
light	1.772	1	0.5225	0.4720339
media	66.252	2	9.7697	0.0001696 ***
shading	0.850	1	0.2507	0.6180406
temperature	0			
fertilizer	143.949	3	14.1515	2.124e-07 ***
Residuals	254.300	75		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Effect of environment on fodder yield

Yield value is accumulation of plant growth that affected by environmental condition (Figure. 3)(In the sprouting trays, yield of hydroponic maize fodder contained white root and green shoots embedded with some media. These system was produced out of 451.4 – 1935.3 g maize seed (91.5% germination rate) along with average plant on 8th and 10th day.

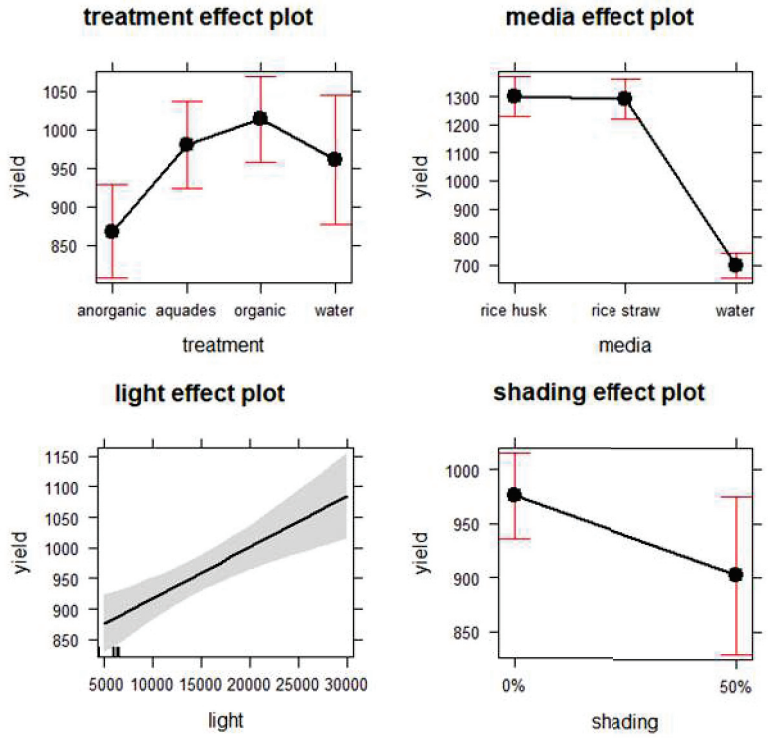
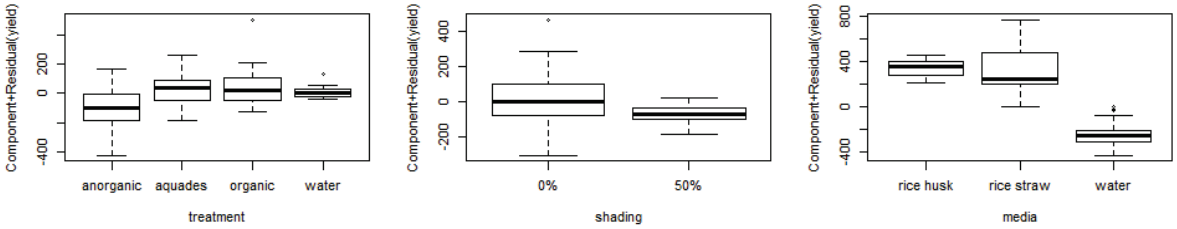


Figure 3. Effect of fertilizer treatment, media, light and shading on fodder yield

The productionconversion ratio in these system was ranged 2 – 6 folds, based on the amount of fresh fodder producedper unit of seed used. The fodder yield in hydroponic system depends on factors such astype and quality of seed(Gebremedhine, 2015b), overall management,temperature inside the greenhouse (Sakamoto and Suzuki, 2015), relative humidityand light (Promratrak, 2017).



The whole portion of green maize fodder was palatable for goat and sheep animal included rice husk and straw that embedded on root. Production potential on limited space including the root tightly embedded with media. At 10 days of growth period 250 g of maize seed was produced 489.9-1935.3 g/trays. At 8 days of growth period 250 g of maize seed was produced 451.4-1935.3 g/trays.

Effect of environment on fodder nutrient

The result of investigation nutrient contentof maize fodder (in dry matter) presented in Table 2. The average DM content of maize fodder was found as 20.03±6.49%, respectively. There was indicated high variation of dry matter content of fodder maize in range 8,87-27.66% between all treatments.

Table 2. Nutrient content on maize fodder

Treatment			Nutrient							
			Ash		Crude Fat		Crude Protein		Crude Fiber	
Fertilizer	Media	Light	(%DM)							
		(%)	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
Water	AQ	100	1.68	7.37	2.13	3.23	9.84	20.39	8.11	19.35
Water	HR	100	2.73	10.84	1.82	4.46	7.11	18.09	14.70	16.84
Water	SR	100	11.11	14.28	1.27	3.62	7.81	14.88	14.38	18.74
Organik	AQ	100	2.00	8.26	2.47	3.05	9.11	21.66	8.14	18.91
Organik	HR	100	6.43	10.07	2.07	3.42	8.38	20.24	10.59	18.95
Organik	SR	100	11.97	16.86	1.52	3.61	9.61	18.32	9.86	18.71
Anorganik	AQ	100	2.75	11.99	2.78	4.74	9.30	18.33	7.41	19.77
Anorganik	HR	100	9.47	15.45	1.71	2.86	8.35	19.60	16.87	20.56
Anorganik	SR	100	12.79	14.70	1.62	3.63	8.91	17.50	8.70	19.60
Aquades	AQ	100	1.68	7.37	2.13	3.23	9.84	20.39	8.11	19.35
Water	AQ	100	1.76	6.82	2.59	3.72	8.61	23.91	7.95	19.13
Organik	AQ	100	2.00	8.26	2.47	3.05	9.11	21.66	8.14	18.91
Anorganik	AQ	100	2.75	11.99	2.78	4.74	9.30	18.33	7.41	17.82
Aquades	AQ	50	2.06	8.48	1.81	2.76	7.20	19.77	5.45	14.70
Water	AQ	50	1.97	7.80	2.49	3.20	8.21	18.85	4.59	14.07
Organik	AQ	50	2.12	8.35	2.32	3.48	8.38	17.88	5.31	15.52
Anorganik	AQ	50	2.76	10.03	2.95	3.55	7.63	18.02	4.78	13.45

Abbreviation: AQ=aquades; HR=rice husk; SR=rice straw; DM=dry matter

The lower%DM of maize hydroponic fodder may be due to the large uptakeof water initiates increasing metabolic activity of restingseeds leads to complete loss of dry weight (starch) during germinatingcycles of hydroponic fodder (Morsy et al., 2013). Value of total ash was found highest ($P<0.05$) in maize fodder that planted in straw rice media as 11.11-12.79% than other maize fodder. The above data manifested that the value of ash was found

higher in rice husk and rice straw media due to media embedded with root.Straw rice contains 10.80-13.30% ash (Sarnklong et al 2010) while husk rice contains 1-17% (Islabao et al, 2014).

The crude protein value was higher in aquades media without fertilizer both of shoot and root than other treatments.The high of protein value in aquades media might due to organical process in media that supressed protein forms during plant growth (Ghersareh, 2015).In all treatments, the crude protein value was higherthan resultsreported by Naik et al. (2013) in hydroponic maize fodder as13.30-13.6% and Naik et al., (2014)as 13.30%.

In other side, the crude fibre content ofmaize fodder harvested under100% light was higher (17.82-20.56%) than maize fodder 50% light (13.45-15.52%). This condition might be due to thebuildup of cellulose, varied proportions of hemicelluloses andlignin (Cuddeford, 1989). ComparableCF values were reported by Naik et al. (2013) ranged as6.37-14.10%.

CONCLUSIONS

From results of the research, it can be concluded that light and media increased plant growth, fodder yield and quality. Fertilizer, temperature and relative humidity have no effect on productivity. In addition, straw rice and husk rice could be fed to animal ruminant and maize fodder increased feed palatability of sheep.

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