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The effect of nitrogen and transplanting age on single bud planting system of sugarcane seed production

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Sugarcane nursery with single bud planting technique is one of new technique in Indonesian which adapted from Columbia with high purity level, uniformly growth, and produce more tiller if compared with conventional technique. This study aims to determine the effect of transplanting age and nitrogen doses on sugarcane plant. The field research was conducted at Trial Research Plantation of ISRI-Pasuruan. This study using split plot design with sugarcane variety as main plot and nitrogen fertilizer dose as subplot. The result showed an interaction between transplanting age and Nitrogen fertilizer dose on sugarcane variety of Bululawang on stalk diameter, stalk length, and stalk weight. On sugarcane variety of PS 862 the interaction occurred on tiller number, stalk diameter and stalk weight. The early transplanting age gave good effect on standard N doses however increasing the N dose until N175, the seed which plant at slower transplanting age (10 weeks) showed higher yield than other transplanting age treatment.

Keywords: N dose, transplanting age, single bud planting, multiplication

INTRODUCTION

Seeds are important production factor however the quality and quantity are low. Preparation of seed through nursery takes six months for each planting period, so it takes a long time for development the production of sugarcane seeds. The sugarcane nursery techniques that take a short time are needed in the sugar industry. One of the factors that determine the success of planting factor is the availability of good quality seed. A good quality of seed characterized by their ability to adapt to the new environments, able to grow on field, healthy and uniformly (Putra et al., 2013)

Sugarcane is a plant which can propagated vegetative. Sugarcane seed usually used sugarcane cuttings with one, two or three shoots. Single Bud Planting (SBP) seedling system is one of the new technique of sugarcane seedling in Indonesia. Method of single bud planting able to produce seed with multiplication rate up to 100 times. One method of single bud planting is bud set. Bud set is one of acceleration method for sugarcane seedling using one bud which obtained by using drill or another tool (Putri et al., 2013). In plant which propagated through seed and seedbeds, planting should be done at appropriate plant stadia.

According the Standard Operation Procedure (SOP) the SBP seedling takes 75 days before they planted because the seed reach the appropriate morphology and physiology age. But

the condition in the field indicates that the eye of sugarcane bud can grow faster in 30 until 60 days. SBP plants produce significant number of tillers (10-15 tiller per hill) so that the multiplication rate is high (Andayanie et al., 2013). To maintain the sufficient number of tillers and support the growth of tillers, its needed the additional of N fertilizer. Application of nutrient with appropriate doses is one of effort to growth younger SBP seeds similar to older SBP seeds. Sugarcane needs higher amount of Nitrogen, therefore it is necessary to determine the precise dose of N fertilizer in sugarcane due to the limited of N nutrient in the soil.

This study aims to determine the effect of Nitrogen dose and transplanting age on agronomy characteristics including the number of tillers, stalk height, stem diameter, number of section and multiplication rate of single bud planting sugarcane system.

MATERIALS AND METHODS

The field research was conducted at Trial Research Plantation of Indonesian Sugar Research Institute (ISRI) from January 2015 until January 2016. Two variety of sugarcane used in this research is Bululawang variety and PS 862 variety with 8 up to 13 number of eyes. A split plot design was used with three times replication. The main plot is transplanting age which consists of U1= 6 WAP (Week After Plant) seeds age; U2= 8 WAP seeds age; U3: 10 WAP seeds age and the sub plot is dose of N fertilizer, there are N1= 100 % N (160 kg N Ha^{-1}) equally with 800 kg ZA Ha^{-1}; N2= 125 % N (200 kg N Ha^{-1}) equally with 1000 kg ZA Ha^{-1}; N3 = 150 % N (240 kg N Ha^{-1}) equally with 1200 kg ZA Ha^{-1}; N4= 175 % N (280 kg N Ha^{-1}) equally with 1400 kg ZA Ha^{-1}. Each combination treatment repeated there times, so it obtained 36 experiment unit. This study observes the number of tillers, stalk height and sugarcane seed production at 1 MAP (Month After Plant) until 6 MAP.

The results of this experiment were analyzed using two wayanalysis of variance (ANOVA)with F test at 5% and 1% level. If there was a significantly different result, it will be continued with HSD test at 5% level (Gomez and Gomez, 1995).

RESULTS AND DISCUSSION

Number of Tillers

On sugarcane variety of Bululawang showed the dose of N fertilizer had not significantly effect to number of tillers, meanwhile a different response occurred on number of tillers for every transplanting age treatment and the dose of N fertilizer on PS 862 variety. Figure 1 showed enhancement on number of tillers at the early growth (1 to 2 MAP) but at 3 MAP occur the decline up to stable at 4, 5 and 6 MAP.

At 10 weeks transplanting age resulted all dose of N fertilizer produce the same number of tillers. Number of tillers which produce at 10 weeks gave a lower number of tillers that other transplanting age treatment. However, if the dose of N fertilizer added (N125) then the produce number of tillers is not significantly different with the number of tillers in the seed which planted at age of 6 and 8 weeks (Table 1). Furthermore, the addition dose of N fertilizer (N150 and N175) could not increase the number of tillers as resulted in the treatment of 6 and 9 weeks. Increasing the Nitrogen fertilizer will increase the number of tillers until the optimum condition are achieved, further the addition of Nitrogen fertilizer addition will have no effect Sugarcane have the ability to produce the tiller in one cluster. Seedling of the tillers is an important link to the growth and development of the plant because each bud will produce the optimal number of stalk. This result supported by Fauconnier (1993) which there is an indication of seed age has significant effect on the number of tillers per cluster and plant population. Soomro et al. (2004) suggests that rapidly transplanting of seed cause the seed will incapable of adjusting to the new circumstances and delayed of seed transplanting may lead to the broken root and may disrupting vegetative plant growth. The proper seed age during the panting in the field is one of the important thing to improve the plant productivity. The effect of planting age can be related to the possibility of root damage in planting process. Plant transplanting reduce the effectiveness area of the roots and removes the hair root which dominant to water absorption (Sharma et al., 2006). The dead tiller is dominated after the plant reach the peak phase of the number of tillers. The lever of dead tillers is generally 30-50% of the total tiller that can survive until they can be harvested (Dewi, 2012)

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age of 6 and 8 weeks (Table 1).

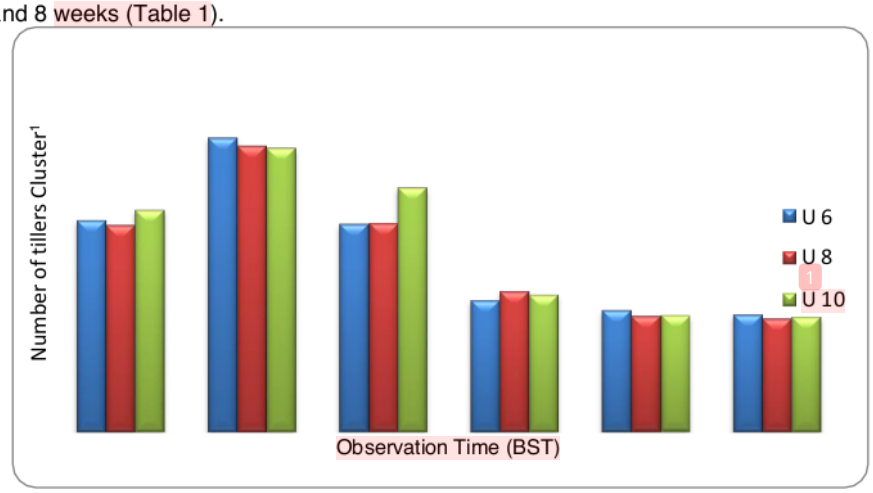

Figure 1. Number of tillers per Cluster on Sugarcane Variety of Bululawang on Transplanting Age Treatment at 1 until 6 WAP

Table 1. Interaction between Transplanting Age and Dose of Nitrogen Fertilizer on Number of Tillers Cluster^{-1} on Sugarcane Variety of PS 862

Treatment	Number of tillers							
	Dose of Nitrogen Fertilizer (%)							
Transplanting Age	N100		N125		N150		N175	
U6	6.26	b	6.83	ab	7.39	a	7.26	a
	B		A		A		B	
U8	7.11	bc	6.82	c	7.68	ab	8.18	a
	A		A		A		A	
U10	6.17	a	6.51	a	6.19	a	6.54	a
	B		A		B		B	
HSD 5%			0.81					

Description: The mean value followed by the same lower case on the same line shows no significant difference according to the HSD Test at the 5% level; The mean values followed by the same upper case in the same column show no significant difference according to the HSD Test at the 5% level, MAP: Month After Planting

Furthermore, the addition dose of N fertilizer (N150 and N175) could not increase the number of tillers as resulted in the treatment of 6 and 9 weeks. Increasing the Nitrogen fertilizer will increase the number of tillers until the optimum condition are achieved, further the addition of Nitrogen fertilizer addition will have no effect.

Sugarcane have the ability to produce the tiller in one cluster. Seedling of the tillers is an important link to the growth and development of the plant because each bud will produce the optimal number of stalk. This result supported by Fauconnier (1993) which there is an indication of seed age has significant effect on the number of tillers per cluster and plant population. Soomro et al., (2004) suggests that rapidly transplanting of seed cause the seed will incapable of adjusting to the new circumstances and delayed of seed transplanting may lead to the broken root and may disrupting vegetative plant growth. The proper seed age during the panting in the field is one of the important thing to improve the plant productivity. The effect of planting age can be related to the possibility of root damage in planting process. Plant transplanting reduce the effectiveness area of the roots and removes the hair root which dominant to water absorption (Sharma et al., 2006). The dead tiller is dominated after the plant reach the peak phase of the

number of tillers. The lever of dead tillers is generally 30-50% of the total tiller that can survive until they can be harvested (Dewi, 2012)

Stalk Height

Treatment of N fertilizer doses gave a significant effect on the stalk height of sugarcane variety of Bululawang (Figure 2). At the early growth of sugarcane, an excessively high N fertilizer dose resulted in a low stalk height. Higher stalk occurred at N fertilizer dose N125 (26.09 cm) than N175 treatment (23.95 cm). Towards the final stage of growth period, the sugarcane plane required high level of N fertilizer dose to stimulate the stalk growth. Using the N150 dose of N fertilizer resulted in stalk height (231.78 cm) which 5 higher that treatment of N fertilizer dose N100 (220.60 cm). However, the transplanting age did not affect the height of stalk. On sugarcane variety of PS 962 showed an interaction between transplanting age and the N fertilizer doses with stalk height (Table 2). The treatment of 8 WAP transplanting with the N fertilizer dose at N125 resulted the higher stalk height if compared with the other treatment. However on sugarcane seed which planting at 10 WAP showed higher of number of tillers if combined with N fertilizer dose N175 (216 cm) and significantly different with lower N fertilizer dose N100 (194.87 cm). In stalk height showed if seed which transplanted at earlier age it proper fertilize with low dose of Nitrogen, but if planted with slower transplanting age (10 weeks) it should be fertilize with dose of N175.

Transplanting age at younger seed cause the growth of roots not inhibited because the formation of plant root is still low (Ashraf et al., 2008). Under certain condition, plant the seeds at the transplanting age of 10 weeks then the dose of N fertilizer which required to achieve the optimum stalk height is N175. This mean that seed planted at the age of 10 weeks require the additional dose of fertilizer to obtain the stalk height as the result obtained when the seeds planted at transplanting age 6 or 8 weeks. Wiedenfeld et al., (2008) stated the adequate of Nitrogen fertilizer determine the plant growth, on of the indicator is the stalk height. Characteristics of stalk height in sugarcane is indicator of sugarcane production, as its related to the stalk weight. Sugarcane stalk is the most important part on the production of sugar because it contains sap, especially in sugarcane which contain thick wall of parenchyma tissue (Allison et al., 2002). Biomass, diameter and plant height are influenced by the varieties of genotypes of each plant. Each variety has its own advantages, whether in terms of plant height, diameter or biomass. Sugarcane seeds from upper stem has good growth because the upper stem have more auxin content (Ahmed et al., 2010).

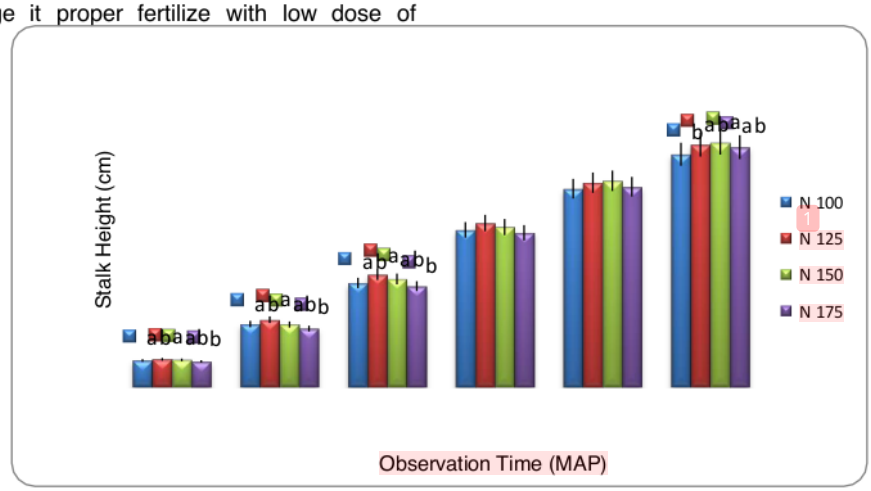

Figure 2. Stalk Height of Sugarcane Bululawang Variety on Treatment of N Fertilizer doses at 1 until 6 WAP

Table 2.Interaction of Transplanting Age and N Fertilizer Doses on Stalk Height of Sugarcane Variety of PS 862 on 5 MAP

Treatment	Stalk Height (cm)							
	Nitrogen Fertilizer Doses (%)							
Transplanting Age	N100		N125		N150		N175	
U6	200.32	a	207.38	a	208.04	a	209.28	a
	A		A		A		A	
U8	199.49	a	200.97	a	208.72	a	206.94	a
	A		AB		A		A	
U10	194.87	b	193.61	b	203.77	b	216.97	a
	A		B		A		A	
HSD 5%	11.02							

Description: The mean value followed by the same lower case on the same line shows no significant difference according to the HSD Test at the 5% level; The mean values followed by the same upper case in the same column show no significant difference according to the HSD Test at the 5% level, MAP: Month After Planting

Table 3. Interaction between Transplanting Age and N Fertilizer Dose on Sugarcane Variety of Bululawang at 6 MAP

Treatment	Sugarcane Weight (kg)							
	N Fertilizer Doses (%)							
Transplanting Age	N100		N125		N150		N175	
U6	132.80	ab	138.60	a	137.40	a	127.00	b
	A		A		A		B	
U8	131.72	ab	130.13	b	136.32	ab	138.42	a
	A		B		A		A	
U10	133.00	a	128.60	a	130.75	a	128.07	a
	A		B		A		B	
HSD 5%	6.91							

Description: The mean value followed by the same lower case on the same line shows no significant difference according to the HSD Test at the 5% level; The mean values followed by the same upper case in the same column show no significant difference according to the HSDTest at the 5% level, MAP: Month After Planting

Table 4.Interaction between Transplanting Age and N Fertilizer Dose on Sugarcane Weight of Sugarcane Variety of PS 682 at 6 MAP

Treatment	Sugarcane Weight (kg)							
	N Fertilizer Doses (%)							
Transplanting Age	N100		N125		N150		N175	
U6	118.54	b	125.20	a	126.90	a	123.12	Ab
	A		A		A		A	
U8	120.52	ab	122.94	a	123.12	a	116.46	B
	A		A		A		B	
U10	123.14	a	126.26	a	124.84	a	127.50	A
	A		A		A		A	
HSD 5%	8,36							

Description: The mean value followed by the same lower case on the same line shows no significant difference according to the HSD Test at the 5% level; The mean values followed by the same upper case in the same column show no significant difference according to the HSD Test at the 5% level, MAP: Month After Planting

Sugarcane Seeds Production

Observation of sugarcane weight per segment showed an interaction of N fertilizer dose and transplanting age in both sugarcane varieties. In Bululawang variety, transplanting age at 6 weeks combined with N125 fertilizer dose had the highest yield of sugarcane per segment but not significantly different with N150 fertilizer dose (Table 3). This mean when the transplanting of seed at age of transplanting 6 weeks, the to obtain the optimal weight of sugarcane should be use N125 or N150 fertilizer dose. The highest yield occurred if the seed are plant at transplanting age 8 weeks with N175 fertilizer dose which 8.25% higher than other transplanting age treatment.

On sugarcane variety PS 862 with transplanting age 6 weeks treatment gave the higher sugarcane weight if combined with N fertilizer doses above standard N125 (Table 4). These results were not significantly different from other transplanting age treatments. However, if de N fertilizer dose increased (N175) then the treatment of transplanting age 10 weeks results in 8.7% which had higher weight if compare with 8 weeks transplanting age treatment. The Nitrogen requirements for plant is the main element that sugarcane needs as it affected field and quality of sugarcane, especially in vegetative phase (Karami et al., 2012, Muchovej et al., 2004)

The productivity of sugar cane per unit of land is determined by the ability of the plants to form the seedlings. Rachmawati (2011) stated that sugarcane tillers are the main factor to obtain the high productivity of sugarcane. More sugarcane seedling formed the more sugarcane yield. The number of stalk per segment and the number of eyes per stalk determine the result of seeds. In Bululawang variety, number of stalk per cluster ranged from 8.05 to 8.91. while the number of eyes between 10.33 to the highest 12.29 eyes per stalk. In PS 862 variety, the number of stalk per cluster ranged from 7.17 to 9.18, while the number of eyes per stalk between 8.93 to the highest of 19,66 eyes per stalk.

On both varieties, the younger age of transplanting results the higher multiplication of sugarcane. The age of seeds affects the number of tillers. In younger sugarcane seed, 30% greater germination was found and the number of tiller 7% higher that old sugarcane (Khan et al., 2005). However, the seeds which plant at older ages, the productivity can be increase if additional doses of N are added to the standard. Fertilization factor also affect the growth of bud. On Bululawang variety, the highest multiplication is found on transplanting age 6 weeks which combined N175 fertilizer dose treatment. While at PS 862 variety found on 8 weeks of transplanting age and N175 fertilizer dose treatment.

The tendency of reproduction and the highest number of bud during the harvest is different in several varieties. The measurement of the success of the phase of transplanting is the parent stalk which able to form 4 – 6 buds. Thus, in every hectare of field can produce 120.000-130.000 of buds (Winarsih and Sugiyarta, 2008).

Table 5. Multiplication Result of Sugarcane Variety of Bululawang on 6 MAP

Treatment	Number of StalkCluster^{-1}	Number of Eyes Stalk^{-1}	Multiplication
U6 N100	8.87	10.99	97.43
U6N125	8.50	11.02	93.69
U6 N150	8.87	11.02	97.73
U6 N175	8.73	12.29	107.37
U8 N 100	8.44	10.56	89.14
U8 N 125	8.80	10.67	93.92
U8 N150	8.63	10.50	90.65
U8 N175	8.05	10.63	85.60
U10N100	8.45	10.33	87.30
U10 N125	8.20	11.15	91.43
U10 N150	8.91	11.57	103.01
U10 N175	8.78	11.01	96.62

Table 6. Multiplication Result of Sugarcane Variety of PS862 on 6 MAP

Treatment	Number of Stalk Cluster^{-1}	Number of Eyes Stalk^{-1}	Multiplication
U6 N100	7.26	10.45	75.82
U6N125	7.83	10.66	83.47
U6 N150	8.39	10.28	86.28
U6 N175	8.26	10.62	87.69
U8 N 100	8.11	8.93	72.39
U8 N 125	7.82	10.20	79.79
U8 N150	8.68	9.97	86.59
U8 N175	9.18	9.92	91.07
U10N100	7.17	10.43	74.73
U10 N125	7.51	9.99	74.97
U10 N150	7.19	10.56	75.94
U10 N175	7.54	10.44	78.80

When both varieties were compared, PS 862 varieties classified as moderate to fast resulted in higher multiplication than Bululawang varieties.

CONCLUSION

The transplanting age and N fertilizer doses shad an effect on the seed multiplication rate. On Bululawang variety, the highest multiplication is found on transplanting age 6 weeks which combined N175 fertilizer dose treatment. While at PS 862 variety found on 8 weeks of transplanting age and N175 fertilizer dose treatment.Bululawang variety provides a higher rate of multiplication compared to PS 862 variety.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

ES designed and performleed the experiments and also wrote the manuscript. EW, BW and SW designed experiments and reviewed the manuscript. All authors read and approved the final version.

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