Evaluation on Performance of Some *Sorghum bicolor* Cultivars as Forage Resources in the Dry Land with Dry Climate

Sajimin[1], Purwantari ND[1], Sarjiman[2], Sihono[3]

[1]1Indonesian Research Institute for Animal Production, P.O. Box 221, Bogor 16002
[2]Yogyakarta Assesment Institute for Agricultural Technology
Jl. Stadion Maguwoharjo No. 22, Sleman, Yogyakarta 55584
[3]National Nuclear Energy Agency of Indonesia, Pasar Jumat, Jakarta
E-mail: djiemin@yahoo.com

(received 19-06-2017.; revised 28-08-2017; accepted 05-09-2017)

ABSTRAK

Sajimin, Purwantari ND, Sarijan, Sihono. 2017. Evaluasi performa beberapa kultivar Sorghum bicolor sebagai sumber hijauan pakan di lahan kering iklim kering. JITV 22(3): 135-143. DOI: http://dx.doi.org/10.14334/jitv.v22i3.1611

Penelitian bertujuan mengevaluasi beberapa kultivar Sorghum bicolor sebagai pakan ternak di lahan kering iklim kering dengan pH tanah 5,4, N 0,08% C/N 9%, P 0,06% dan K 0,01%. Sembilan kultivar S. bicolor (Super 1, Super 2, Numbu, Kawali, G2, G5, PAC 537, PAC 593 dan PAC 501) ditanam dengan jarak tanam 15 x 75 cm. Pupuk yang digunakan kompos 4 kg/plot, SP-36 160 g/plot, KCl- 144 g/plot dan urea 240 g/plot. Rancangan percobaan acak kelompok dengan 3 ulangan. Pengamatan meliputi tinggi tanaman, umur berbunga, produksi hijauan tanaman primer dan ratun, serta kualitas hijauan. Hasil penelitian menunjukkan pertumbuhan tanaman primer tidak beda antar kultivar. Pada tanaman primer umur 65 hari, sorgum Super 2, PAC 537 dan Kawali belum berbunga. Produksi biomas bervariasi antar kultivar pada tanaman primer dengan kisaran 11.35 - 26.17 kg/16 m^2. Produksi biomasa tertinggi dicapai oleh kultivar PAC 537 (26.17 kg/16 m^2 setara dengan 16.34 ton/ha), berbeda nyata dengan G2 (11,35 kg/16 m^2) dan tidak berbeda nyata dengan kultivar yang lain. Pada tanaman ratun 1 umur 45 hari, kultivar Super 2, G5 dan Super 1 menunjukkan pertumbuhan yang lebih cepat. Produksi biomasa meningkat pada ratun 1 berkisar 19,88 kg/16 m^2. Kultivar PAC 537 menghasilkan biomasa tertinggi (30,14 kg/16 m^2) dan tidak berbeda nyata dengan kultivar yang lain kecuali galur G2. Produksi biomasa ratun II menurun berkisar 1,83 kg/16 m2 – 4,77 kg/16 m^2 dan meningkat pada ratun III, yang berkisar 15,72 kg/16 m^2 – 26,05 kg/16 m^2. Kualitas hijauan ratun 1 lebih baik dibanding tanaman utama dan terendah ratun II. Disimpulkan bahwa kultivar sorgum Super 1, Super 2 dan PAC 537 dapat direkomendasikan sebagai sumber hijauan pakan ternak yang paling potensial.

Kata Kunci: Sorghum, Kultivar, Produksi Hijauan, Kualitas

ABSTRACT

Sajimin, Purwantari ND, Sarijan, Sihono. 2017. Evaluation on performance of some *Sorghum bicolor* cultivars as forage resources in the dry land with dry climate. JITV 22(3): 135-143. DOI: http://dx.doi.org/10.14334/jitv.v22i3.1611

The aim of this study was to evaluate the performance of several Sorghum bicolor cultivars as forage on a dry land with pH of 5.4, N of 0.08%; C/N of 9%, P of 0.06% and K of 0.01%. Nine cultivars of S. bicolor (Super 1, Super 2, Numbu, Kawali, G2, G5, PAC 537, PAC 593 and PAC 501) were evaluated. Plot size was 16 m2 with space planting of 15 x 75 cm. The experimental design used was randomized block design with three replications. Parameters observed were plant height, time of flowering, forage production and quality. The result showed that the primary plant growth was not different in all cultivars. In the 65 days old primary plant, the Super 2, PAC 537 and Kawali had no flower yet. Biomass production varied in primary plant between cultivars of 11.35 - 26.17 kg/16 m2. The highest biomass production was obtained in PAC 537 of 26.17 kg/16 m2 (16.34 t/ha) which were significantly higher than G2 of 11.35 kg/16 m2 (7.09 ton/ha) and was not significantly different with other cultivars. In the 45 days ratoon I, Super 2, G5 and Super 1 showed faster growth. Biomass production increased in the ratoon I around 19.88 kg/16 m2 (12.42 ton/ha). PAC 537 produced the highest biomass of 30.14 kg/16 m2 (18.84 ton/ha) and was not significantly different with other cultivars, except with the G2. Biomass production of ratoon II decreased around 1.83 kg/16 m2 (1.14 t/ha)–4.77 kg/16 m2 (2.98 t/ha) and increased in the ratoon III of 15.72 kg/16 m2 (9.82 t/ha)–26.05 kg/16 m2 (16.28 t/ha). The quality of forage ratoon I was better compared to the primary plant with the lowest one was in ratoon II. It could be concluded that Super 1, Super 2 and PAC 537 cultivars might be recommended as potential forage.

Key Words: Sorghum, Cultivar, Biomass Production, Quality

INTRODUCTION

Feed availability for ruminant, especially forage in dry land is highly influenced by season. The forage is available abundantly in the rain season, but rare in the dry season. So that in quantity, quality and continuity the forage is not guaranteed throughout the year leading to the not optimal production (Nugraha et al. 2013). A problem commonly faced in ruminant rearing is the unavailability of adequate forage especially in the dry season (Aswar 2005). Besides, during the dry season, the quality of forage commonly low with low productivity in the dry land area. The productivity of the elephant grass (*Pennisetum purpureum*) in wet climates area is able to reach 300 tonnes/ ha/year of fresh weight on a fertile land (Prawiradiputra et al. 2012). However, in a dry area with dry climate or in the areas with a relatively long dry season, this grass provides a much lower fresh weight production as about 48-70 tonnes/ha/year. To overcome the forage availability issue, it is necessary to find a multifunctional and easy to adapt to a dry land with dry climate forage.

The crop is the cheapest forage resource which is an economic production input in the livestock industry. One of the crops potential to be developed in a dry land with dry climate is Sorghum spp. Sorghum is one of the crops that can be used as a source of forage for ruminants, the seeds can be used for food and feed materials. Sorghum grows well in a dry land with dry climate or in the land with limited irrigation (Marsalis 2011). Study of sorghum is widely conducted in Indonesia, especially as a food resource (Chavana et al. 2009) as well as the study of bioenergy obtained by processing its stem as ethanol material resource (Lestari & Dewi 2015).

There are much sweet sorghum cultivars available so far which its productivity has been improved to be cultivated both as food and feed resource (Deb et al. 2004; Efendi et al. 2013). Sorghum breeding has been widely applied for both as feed and bioenergy through hybridization and irradiation, namely sorghum pahat (pangan sehat); sorghum samurai 1 and 2 (sorghum from radiation mutation) (Surya & Soeranto 2006; Soeranto et al 2011). Sweet sorghum produces higher bioethanol than a cane (80 vs. 50 L/ha/yr) and cassava (45 L/ha/yr) (Indonesian Bioethanol Entrepreneurs Association 2010).

Many sorghum cultivars have bifunction as food and feed resource for both chopped and hay and silage. Sorghum waste (fresh leave and stem) can be used as forage. Sweet sorghum leaves production is around 14-16% of the fresh weight of stem or about 3 ton of fresh leave pe hectare of the total production of 20 ton/ha. Sorghum leave contains crude protein (7.82%) higher compared to elephant grass (6%) and cane ratoon (5.33%) (Sirappa 2003). This study was aimed to evaluate the most optimal sorghum cultivar in producing biomass in a dry land with dry climate as forage.

MATERIALS AND METHODS

The study was conducted in a dry land with dry climate in Gunung Kidul district, Special Region of Yogyakarta. It had rainfall of 3230.5 mm/year with dry season period more than six months and wet season period of 4 months classifies as type D (Oldeman 1975). Rainfall and rainy day observations were performed during this research using OBS rain scraper. The data were shown in Table 1.

The land used was processed perfectly of weeds cleaning and soil loosing. Soil samples were analyzed for its nutrient of pH, organic material (C/N ratio), P and K. This is performed to confirm nutrient amount should be added in the fertilization. Fertilizer added followed the standard of sorghum cultivation (Suminar et al. 2017) consisted of commercial compose fertilizer by 4 kg/pot (2.5 ton/ha) and chemical fertilizer by 160 g/plot (100 kg/ha), KCl- 144 g/plot (90 kg/ha) and urea by 240 g/plot (150 kg/ha). Those materials addition assumed to rich the soil nutrient required by sorghum: 120 kg/ha N, 36 kg/ha P2O5 and 90 kg/ha K2O (Suminar et al. 2017). The fertilization was performed at the beginning of planting with no re-fertilizing during the research until the harvesting return III.

Nine Sorghum spp cultivars derived from a breeding program of Indonesian Cereal Research Institute (Super 1, Super 2, Numbu, Kawali), National Nuclear Energy Agency of Indonesia (mutant G2 and G5) also from Australia (PAC 537, PAC 593 and PAC 501). Each cultivar was planted in a 4 x 4 m plot with a spacing of 15 x 75 cm. Each hole was filled with 3 seeds which were only one seedling being maintained then. A randomized block design with 9 treatments and 3 repetitions.

The observation was conducted to the primary and ratoon plant. The primary plant was a first plant of the seed planting, while the ratoons were the new bud growing on the felled stem. The primary plant was harvested at 65 days and the ratoon was re-harvested at 45 days for three times (I, II and III). The variables observed were heigh, the time of first flowering, forage production, and the quality of forage. The height was measured from the top of the soil to the highest leaf tip using meter measuring instrument (3 m). The primary plant was harvested at 65 days (approaching flowering) by cutting of 10 cm soil surface. Then, the harvesting of the I, II, and III ratoons was done 45 days. The fresh biomass was weighed immediately using a two-digit scale. A 2.5 kg were taken composite, chopped and dried in the 60°C oven for 48 hours, then milled to flour. A 500 g meal samples were analyzed at the laboratory of Indonesian Research Institute for Animal Production, Ciawi-Bogor. Data were tabulated in the Excel program and statistically analyzed using SAS.

Table 1. Rainfall for 17 months of research in the dry land with dry climate of Gunung Kidul district, Yogyakarta

No/Month	Rainfall (mm)	Rainy day/ month
Year: 2011		
January	399	16
February	347	18
March	160	11
April	162	4
May	160	4
June	65	3
July	31	3
Augst	0	0
September	0	0
October	0	0
November	95	2
December	385.5	20
Year: 2012		
January	295	14
February	302.5	14
March	384	18
April	342.5	15
May	102	6

RESULTS AND DISCUSSION

Chemical characteristic of soil in this study consisted pH 5.4; organic material with the low ratio of C/N (9%); very low in N (0.08%); C (0.08%) and K (0.08%); but very high in P (116 ppm). It can be concluded that the soil was less fertile with low organic material and sandy clay texture. Purwowidodo (1993) and Rahmi & Biantary (2014) described that fertile soil consists CN ratio of >10% and PH>6. A high ratio of C/N is able to provide abundant energy for the soil organisms. The anorganic N compound available in the soil is converted into organic N in the soil organism body. In this stage, the decomposition rate of organic material is at the lowest point.

Sorghum plant height

The height of 65 days sorghum plant was varied between the cultivars for about 99.67 – 118.33 cm. While the height of 45 days ratoons I, II and III was around 79.86 – 110.15%; 7.76 – 63.61%; and 30.96 – 81.97% respectively. Statistical analysis showed no significant differences in all cultivars both the primary and ratoon I, II and III plants (Table 1).

The sorghum cultivars are very diverse, both in terms of production, harvest age, seed color, taste, and quality of its processed seed. This study results differed from those reported by Purnomohadi (2006), which reported that four sweet sorghum cultivars, namely Rio, Cawley, Wray, and Keller showed the same vegetative growth in both 50 and 100 days after planting cutting age (primary plant). Heigh range of 50 and 100 days sorghums each was 51.61-58.85 cm and 63.03-67.53 cm. This indicates that those four cultivars have the same response to the environment condition (climate and nutrients content in the soil). The primary plant in this study had the shortest (99.67 cm) height in the G5 cultivar and the highest was in the Super 2 cultivar (118.33 cm) in the same climate condition. No significant difference of all the nine cultivars in this study indicates a same response to the climate condition. Different height of 65 days sorghum in this study with the 100 days sorghum in the Purnomohadi (2006) might be caused by different place of planting. Purnomohadi (2006) planted in the polybag, while in this study the sorghum was planted on the ground.

The growth of 45 days ratoons showed faster than the primary plants (Table 2). Ratoons I, II and III, Super 2, G5 and Super 1 cultivars showed faster growth than other cultivars. The factors that may influence the growth of the ratoons plants are the quality of the first plant: the genotype on height, number of leaves and stem diameter (Efendi et al. 2013; Meliala et al. 2017). A relative similar mass and height indicate that the nine cultivars have the same quality.

Flowering phase

From total 240 trees of 65 days after planting sorghum, five cultivars have not flowered, namely: Super 2, G5, Kawali, PAC 593, and PAC 537 (Table 3). The Super 2 and PAC 593 were the slowest flowering compared to other cultivars. It was only 4.8% pregnancy in the Super 2 cultivar without flowering and only 5.6% of pregnancy without flowering in the PAC cultivar. Only one cultivar that had a short flowering period (67-70 days) with 9 flowering plants (4.5% of total population) in the 65 days after planting (Table3).

Efendi et al. (2013) said that ratoon plant had a faster production which is closely related to the carbohydrate supply from photosynthesis process of the primary plant stored in the roots and stems which that translocated for bud initiation. A cultivar with the most flowering in 65 days after planting was Super 1 (Table 3). This flowering period was faster than the previous study conducted by Revy et al. (2014) that reported 90-92 days of flowering period.

Table 2. Average heigh of primary and ratoons plant of nine sorghum cultivars

Cultivars	Average heigh of primary plant (65 days)	Average heigh of ratoons I plant (45 days)	Average heigh of ratoons II plant (45 days)	Average heigh of ratoons III plant (45 days)
PAC 501	102.67±15.06	190.40±9.71	136.27±14.74	138.80±24.94
Super 2	118.33±25.89	248.67±45.09	193.60±29.91	198.93±31.00
G5	99.67±34.05	234.80±13.72	168.87±14.70	215.33±29.32
Kawali	105.33±17.57	179.27±7.58	115.40±21.07	154.33±20.82
PAC 593	106.33±42.22	234.87±37.07	147.33±24.57	169.00±44.73
Numbu	109.67±49.58	220.20±32.69	131.07±22.11	173.73±39.31
G2	107.00±34.70	200.40±37.75	107.40±27.31	150.27±38.62
Super 1	102.00±39.84	242.20±23.09	165.07±23.77	213.87±19.42
PAC 537	116.33±26.24	183.53±7.97	141.00±11.66	130.53±9.39

This difference of flowering period is highly influenced by the different of planting location, especially the climate (rainfall, temperature, and nutrient content). The research of Revy et al. (2014) was conducted in Riau, while this study was conducted in Yogyakarta, where there was no rain in August-October which did not affect the flowering period. A cultivar with the slower flowering period would have longer vegetative phase. With this characteristic, this cultivar is potential as a forage resource.

Maturation phase of forage influences its quality (Ball et al. 2001; Ayub et al 2012). Therefore, forage with longer vegetative phase would keep forage quality longer. Flowering age of a plant is influenced by genetic and environment (Widyastuti et al (2012). Super 1 cultivar could be concluded to have the fastest flower age. In this study, all nine cultivars were planted in the same climate and soil condition, so that it was likely, the flowering age was influenced by genetic. This is in accordance with the report of Darjanto & Satifah (1987) in Pasaribu et al. (2015) who said that the transition from vegetative period to generative is mostly determined by genetic and the rest of it is temperature, light, water and nutrient.

Table 3 showed that in the ratoon I all cultivars have been flowered in 45 days after harvesting of the primary plant, so it might start flowering before 45 days. The PAC 537 cultivar had the fewest booting and flowering (<50%). The appearance of flowering in 45 days in the Ratoon I was at the same month of low rainfall (31-65 mm) with the rainy day of 3 days. That condition spurs the flowering (Ibrahim et al. 2011).

Fresh forage production

Primary plant harvest was done in 65 days after planting before flowering. However, in the 65 days, PAC 501, Numbu, G2 and Super 1 cultivars had been flowered (Table 3). The production of upper part of a plant consisting of leaves and stems varied between all cultivars of 7.09 – 16.36 ton/ha (Table 4). The highest production of 16.36 ton/ha was in PAC 537 cultivar followed by Super 1 cultivar of 14.58 ton/ha. It was not significantly different (P<0.05) with other cultivars, except the G2 of 7.09 ton/ha.

Forage production of the primary plant was lower than previous study report. Super 1 and 2 cultivars are an inbred cultivar of sorghum with 30-40 ton/ha of biomass potential as a renewable energy source. Those two cultivars could reach 3 to 4 meters with seed production of 5-6 ton/ha whic is potential to be used as silage (Indonesian Cereal Research Institute 2011).

Table 3. The number of booting and flowering of nine sorghum cultivars of the primary plant in 65 days after planting and ratoons plants in 45 days after planting

Cultivar	Primary plant in 65 days after planting		Ratoon I plant in 45 days after planting	
	Booting	Flowering	Booting	Flowering
PAC 501	134	35	164	99
Super 2	6	0	76	105
G5	36	0	219	160
Kawali	32	0	194	36
PAC 593	7	0	203	158
Numbu	58	9	124	78
G2	51	7	131	92
Super 1	81	148	185	286
PAC 537	63	0	38	21

Table 4. Fresh forage production of primary and ratoon plant in dry land with dry climate in Kunung Kidul District, Yogyakarta

Cultivars	Production of primary plant		Production of primary plant					
			Ratoon I		Ratoon II		Ratoon III	
	kg/16 m^2	ton/ha	kg/16 m^2	ton/ha	kg/16 m^2	ton/ha	kg/16 m^2	ton/ha
PAC 501	19.26	12.04^{ab}	2.43	1.52^{ab}	22.35	13.97^{ab}	16.70	10.44^{cd}
Super 2	14.17	8.86^{ab}	2.97	1.86^{ab}	22.76	14.22^{ab}	24.56	15.35^{abc}
G5	17.53	10.96^{ab}	3.23	2.02^{ab}	27.77	17.36^{ab}	15.72	9.85^{d}
Kawali	20.23	13.43^{ab}	2.30	1.44^{b}	25.28	15.80^{ab}	20.65	12.91^{abcd}
PAC 593	16.54	10.34^{ab}	2.63	1.64^{ab}	24.41	15.26^{ab}	20.16	12.60^{abcd}
Numbu	13.77	8.61^{ab}	2.22	1.39^{b}	22.21	13.88^{ab}	18.13	11.33^{abcd}
G2	11.35	7.09^{b}	1.83	1.14^{b}	19.88	12.42^{b}	17.62	11.01^{bcd}
Super 1	23.33	14.58^{ab}	2.67	1.67^{ab}	27.86	17.41^{ab}	26.05	16.28^{a}
PAC 537	26.17	16.36^{a}	4.77	2.98^{a}	30.14	18.84^{a}	25.76	16.10^{a}

The same superscript in the same column shows not significant difference (P<0.05)

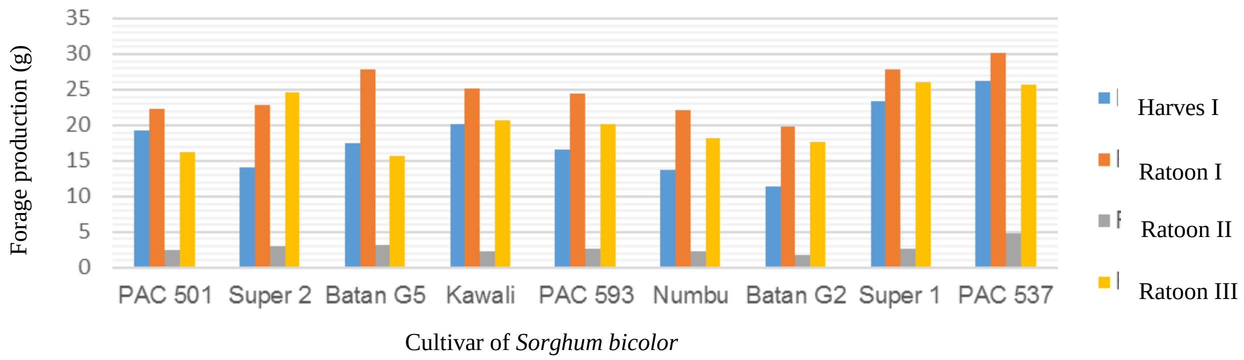

Figure 1. Forage production of nine cultivars of *Sorghum bicolor* in primary, ratoon I, ratoon II and ratoon III planted in the dry land with dry climate in Gunung Kidung, Yogyakarta.

The lower result in this study was suspected to be influenced by climate and rainfall in Gunung Kidul and low quality of the organic material of the soil. Subagio & Aqil (2014) reported that Super 1 and 2 cultivars from Sumba-East Nusa Tenggara had a height stems of 2.16-2.3 m and biomass production of 38.7–39.3 ton/ha from two ratoon harvesting in 105-115 days planted in Indonesian Cereal Research Institute.

In the ratoon I phase, forage production pattern was similar to the primary plant. The PAC 537 produced the highest forage of 18.42 ton/ha and significantly different with the G2 (12.42 ton/ha). In the ratoon II phase, it was at the time of the long dry season, where there was no rain at all for 3 months before the harvesting (Table 1), so that the plant only depended on the residual moisture of soil for several months before. Even though the production of forage decrease up to 84.2-90.9% than the ratoon I (Table 4), in the condition of no rain at all, the farmers still could provide forage of 2.98 ton/ha which is equal to 993 heads cattle with the body weight of 300 kg.

The forage production of ratoon III significantly increased than the ratoon II. According to the data, November was the early rainfall with two days of rainy day and 95 mm of rainfall. In December, the rainfall was relatively high of 385 mm with the rainy day of 20 days, while in January 2015, the rainfall still high (295 mm) with the rainy day of 14 days (Table 4). This indicates that water availability highly influences the growth of sorghum. All this time, Sorghum bicolor is cultivated only up to ratoon I and II (Efendi et al. 2013). However, in this study sorghum cultivar could be harvested up to ratoon III. This is in accordance with a research result of Tsuchihashi & Goto (2008) that sorghum could result in ratoon III both in dry and wet seasons so that it could be 2-3.

Table 5. Analysis of forage nutrient of some cultivars of Sorghum bicolor of primary and ratoon planted in dry land with dry climate in Gunung Kidul, Yogyakarta

Cultivar		DM (%)	CP (%)	CF (%)	Energy Kcal/ kg	Ash	NDF (%)	ADF (%)	Ca (%)	P (%)
PAC 501	Primary	23.64	8.66	3.51	4021	10.15	67.07	44.43	0.56	0.34
	Ratoon I	19.26	11.19	2.80	3747	12.68	65.40	42.74	0.63	0.37
	Ratoon II	23.01	6.23	5.31	4160	5.46	69.32	41.00	0.14	0.09
Super 2	Primary	22.57	9.32	2.81	3963	9.77	65.81	42.10	0.52	0.35
	Ratoon I	23.55	10.36	2.49	3722	11.34	66.28	43.78	0.73	0.27
	Ratoon II	22.88	4.56	3.94	4096	6.78	72.49	44.62	0.14	0.07
G5	Primary	23.76	10.31	3.12	3863	9.99	61.83	40.10	0.84	0.22
	Ratoon I	20.27	10.32	2.68	3857	12.21	67.40	46.04	0.86	0.23
	Ratoon II	22.72	8.37	4.38	4139	6.12	65.89	38.54	0.29	0.12
Kawali	Primary	26.57	10.78	3.23	3931	9.79	66.32	42.99	0.65	0.26
	Ratoon I	19.34	9.78	2.63	3755	11.34	64.28	42.19	0.86	0.25
	Ratoon II	26.90	8.14	4.83	3857	7.85	69.50	41.43	0.47	0.18
PAC 593	Primary	27.19	7.32	2.53	3841	9.30	67.32	40.83	0.65	0.23
	Ratoon I	22.11	8.14	2.49	3661	14.26	67.82	45.88	0.91	0.32
	Ratoon II	26.74	5.64	4.70	4040	6.51	69.07	43.06	0.33	0.15
Numbu	Primary	20.35	9.07	2.95	3805	8.96	62.12	36.39	0.56	0.20
	Ratoon I	20.65	11.59	2.70	3843	11.42	64.84	42.36	0.97	0.37
	Ratoon II	20.96	6.49	5.14	4134	5.98	67.82	45.92	0.18	0.09
G2	Primary	25.98	11.53	3.22	4002	9.00	67.79	37.09	0.59	0.33
	Ratoon I	15.87	13.65	3.37	4007	11.42	66.92	42.62	0.77	0.34
	Ratoon II	25.82	6.05	3.93	4088	5.89	68.25	41.03	0.24	0.08
Super 1	Primary	26.03	11.58	2.72	3939	8.41	68.52	42.29	0.51	0.31
	Ratoon I	19.50	9.84	3.00	3862	12.81	68.78	44.96	0.99	0.21
	Ratoon II	24.72	5.10	4.31	4068	6.33	69.98	42.65	0.24	0.08
PAC 537	Primary	24.18	6.73	3.05	3947	8.78	66.15	40.75	0.65	0.29
	Ratoon I	22.69	8.72	2.93	3683	11.86	67.92	44.62	0.86	0.20
	Ratoon II	23.56	5.87	3.92	4035	6.77	67.40	44.73	0.25	0.14

Description: DM(dry material). CP (crude protein).CF (crude fat). NDF (neutral detergent fiber). ADF (acid detergent fiber). Ca (calsium) P (phosphor)

Forage production in Table 4 shows even though the Super 1 produces the highest biomass but it is not significantly different with the PAC 537, Numbu, PAC 593, Kawali, and Super 2. The lowest biomass production significantly produced by the G5 followed by PAC 501 compared the other cultivars. This decrease is suspected to be influenced by the lack of nutrients in the soil, so that it requires more nitrogen (N) administration to overcome the difference in production of the primary and ratoon plant (Efendi et al. 2013).

Forage 1 shows forage production of all cultivars decreases in the ratoon II phase. The PAC 537, consistently has the highest production both in the first harvest, ratoon I and ratoon II.

Table 6. Dry material and organic material digestibility of cultivars of Sorghum bicolor of primary and ratoon I planted in dry land with dry climate in Gunung Kidul, Yogyakarta

Cultivar		DMD (%)	OMD (%)
PAC 501	Primary	74.67	73.07
	Ratoon I	71.18	70.72
Super 2	Primary	75.95	74.29
	Ratoon I	73.25	71.31
G5	Primary	75.31	74.01
	Ratoon I	65.74	63.06
Kawali	Primary	56.11	53.20
	Ratoon I	66.85	64.19
PAC 593	Primary	70.37	69.23
	Ratoon I	51.92	47.97
Numbu	Primary	78.31	76.35
	Ratoon I	61.55	59.21
G2	Primary	54.55	51.54
	Ratoon I	41.19	36.57
Super 1	Primary	60.51	58.18
	Ratoon I	53.91	51.17
PAC 537	Primary	60.88	58.94
	Ratoon I	62.06	59.57

The decrease in biomass production from the first harvest to the ratoon II was caused by the decrease in its growth percentage. Effendi et al. (2013) also reported that primary plant of 15021A of Sorghum bicolor had highest biomass production of 63.4 ton/ha and decreased drastically into 24.6 ton/ha in the ratoon I and 20.6 ton/ha in ratoon II. The drastic decrease of the ratoon I to ratoon II was caused by the decrease in growth percentage of the ratoon I (44.2%) to ratoon II (33.3%).

Growth percentage of the ratoon would determine the number of the plant would be harvested per area unit which affected fresh biomass production. The genotype 15011A has a high enough potential ratoon with the growth percentage of the ratoon I of 73.0% and ratoon II of 54.2%, so that fresh biomass production of the primary plant, ratoon I and ratoon II. The difference in biomass production in this study of the primary and ratoon I because the forage production was measured before the flowering period which is intented to maintain the quality of forage. High production in ratoon I and the production decrease in ratoon II were influnced by the season. The rainfall in ratoon I was 31 mm with the rainy day of 3 days, while the rainfall in ratoon II was 0 mm (Table 1). Besides, it was also influenced by age of the plants, where the ratoon plants were more mature compared to the primary plants and the period of photosyntate acumulation to the biomass became lower (Efendi et al. 2013).

Nutrient in the forage

Chemical analyzes were performed on the upper part of the plant on the primary, ratoon I and ratoon II. The primary forage consisted protein of 6.37%-11.58% of DM, NDF of 61.68-68.52%, ADF of 36.39-44.43%, Ca of 0.51 %-0.84% and P 0.20 - 0.35% (Table 5). Crude protein in this study was higher than that reported by Sirappa (2003) that the leaves and stems contained crude protein of 7.82% and 4.4% respectively and crude fiber of 28.94% and 32.30% respectively. Higher crude protein content in the primary, ratoon I and ratoon II was because the crops harvested as they approached the flowering period at 45 days of age. This is the right age to be used as feed because it contains optimum nutrient. Atis et al (2012) also reported that the right time to harvest sorghum for feed was before the seed physiology mature where it can be obtained the highest productivity and quality.

Dry matter and organic matter digestibility ranged from 54.55-78.31% and 51.54-76.35%, respectively (Table 6). This value was higher compared to the digestibility of straw of other cultivars reported by Praptiwi et al (2016), where three sorghum cultivars tested had dry material digestibility ranging from 45.80-48.93 and organic material digestibility ranged from 46.89 to 50.11%. In the ratoon I, the protein content of forage was higher than the first harvest and the ratoon II was about 8.14-13.65% (Table 5). Ca and P content of ratoon I was higher than the primary and II plants. Crude protein (ranged from 4.56-8.37%) content of ratoon II forage was lower than those of primary and ratoon I (Table 5).

The increase in stem and leaf growth and crude protein level (Escalada & Pluchnett 1977) was as a result of the absorption of the N of urea and organic fertilizers or the one existed in the soil by the roots which then was delivered to stems and leaves. Bogdan (1977) stated that cultivars and species of different genetic properties will affect their response to the formation of crude protein. Besides the genetic factors and crude protein content, crude fiber content of a plant is also influenced by climate, soil fertility where they grow and the age of plant (Atis et al. 2012; Sher et al. 2016).

Sorghum is adaptive in the tropics and drought tolerant, so that it has a good opportunity to be developed as forage. The development is a viable alternative. It should be done to meet forage demand in the dry areas in Indonesia increase which continues to increase. The results showed that the nutrient content of sorghum was not much different from corn, sugar cane bud and elephant grass, so that it has the same dry and organic materials digestibility.

CONCLUSION

Sorghum could grow and adapt well in a dry land with dry climates and long dry season. Forage production in primary plants and the three ratoons varied between cultivars and harvest time. Forage production of PAC 537, Super 1 and Super 2 were consistently highest in both primary and ratoon I, II and III. The highest forage quality was achieved in the ratoon I and the lowest was in the ratoon II. Biomass production was 18.84 ton/ha/harvest with the crude protein content of 5.87- 8.72%, dry matter digestibility of 62.06% and organic matter digestibility of 59.57%. These three cultivars were most potential as forage resources in a dry land with dry climate.

REFERENCES

Aswar R. 2005. Peran tanaman pakan ternak sebagai tanaman konservasi dan penutup tanah di perkebunan. Prosiding Lokakarya Tanaman Pakan Ternak. Bogor (Indones): Pusat Penelitian dan Pengembangan Peternakan. p. 18-24.

Atis A, Konuskan O, Duru M, Gozubenli H, Yilmez S. 2012. Effect of harvesting time on yield composition and forage quality of some forage Sorghum cultivars. Int J Agric Biol. 14:879-886.

Ayub M, Khalid M, Tariq M, Elahi M, Nadeem MA. 2012. Comparison of sorghum genotypes for forage production and quality. J Anim Plant Sci. 22:733-737.

Indonesian Cereal Research Institute. 2011. Pemanfaatan batang sorghum untuk produksi etanol. Maros (Indones): Balai Penelitian Tanaman Serealia.

Ball DM. Collins M. Lacefield GD. Martin NP. Mertens DA. Olson KE. Putnam DH. Undersander DJ. Wolf MW. 2001. Understanding forage quality. American Farm Bureau Federation Publication 1-01. Park Ridge. www.uky.edu/Ag/forage (2/8/2015)

Bogdan AV. 1977. Nutritive value. tropical pasture and fodder plans. London and New York: Longman Inc. p. 14-18.

Chavana UD, Patil JV, Shinde MS. 2009. Nutritional and roti quality of sorghum genotypes. Indones J Agric Sci. 10:80-88.

Deb UK, Bantilan MCS, Reddy BVS, Bramel PJ, Kameswara Rao N. 2004. Impact of improved sorghum cultivars on genetic diversity and yield stability. In Sorghum genetic enhancement: research process. dissemination and impacts (BantilanMCS. Deb UK. Gowda CLL. Reddy BVS. Obilana AB and Evenson RE. eds.). Patancheru 502 324. Andhra Pradesh. India: International Crops Research Institute for the Semi-Arid Tropics. p. 225-234

Efendi R, Aqil M, Pabendon M. 2013. Evaluasi genotipe Sorghum manis (Sorghum bicolor (L.) Moench) produksi biomas dan daya ratun tinggi. Penelitian Pertanian Tanaman Pangan. 32:116-125.

Escalada RG, Pluchnet DL. 1977. Ratoon cropping of Sorghum. origin. Time of Appearance and fate of Tillers. Agron J. 69:341-346.

Ibrahim AA, Ati FO, Adebayo AA. 2011. Effect of climate on the growth and yield of sorghum *(Sorghum bicolor*) in Wailo. Ganjuwa Local Government Area. Bauchi State. Res J Environ Earth Sci. 3:469-472.

Lestari EG, Dewi IS. 2015. Evaluasi dan seleksi galur mutan sorgum manis varietas numbu hasil mutasi. Seminar Nasional Biologi II.

Marsalis MA. 2011. Sorghum Forage Production in New Mexico. Guide A-332. New Mexico State University and the U.S. Department of Agriculture cooperating. p. 1-12.

Meliala MG, Trikoesoemaningtyas, Sopandie D. 2017. Keragaan dan Kemampuan meratun lima genotype Sorgum. J Agronomi Indonesia. 45:154–161.

Nugraha BD, Handayanta E, Rahayu ET. 2013. Analisis daya tampung (carrying capacity) ternak ruminansia pada musim penghujan di daerah pertanian lahan kering Kecamatan Semin Kabupaten Gunungkidul. Trop Anim Husb. 2:34-40.

Oldeman LR. 1975. An agroclimatic map of Java. contributions No.17. Central Research Institute for Agriculture. Bogor.

Pasaribu RP, Yetti H, Nurbaiti. 2015. The Effect of main branch pruning and giving liquid organic fertilizer complementary on the growth and yield of Tomato (*Lycopersicum esculentum* Mill). JOM FAPERTA. 2:14P.

Prawiradiputra BR, Sutedi E, Sajimin, Fanindi A. 2012. Hijauan pakan ternak untuk lahan sub-optimal. Bogor (Indones): Pusat Penelitian dan Pengembangan Peternakan, Badan Penelitian dan Pengembangan Pertanian. 63 p.

Purnomohadi M. 2006. Potensi penggunaan beberapa varietas sorghum manis (*Sorghum bicolor* (l.) moench) sebagai tanaman pakan. Berk Penel Hayati. 12:41–44.

Purwowidodo. 1993. Telaah Kesuburan Tanah. Bandung (Indones): Angkasa Bandung.

Rahmi A, Biantary MP. 2014. Karakteristik sifat tanah dan status kesuburan tanah lahan pekarangan dan lahan usaha tani beberapa kampong di Kabupaten Kutai Barat. ZRAA'AH. 39:30-36.

Revy AP, Zuhry E, Nurbaiti. 2014. Pertumbuhan dan produksi berbagai varietas sorgum (*Sorghum bicolor* L.) dengan pemberian pupuk urea. JOM Fak Pertanian. 1.

Sher A, Ansar M, Ijaz M, Sattar A. 2016. Proximate analisis of forage sorghum cultivar with different doses of nitrogen and seed rate. Fields Crops. Turk J. 21:276-285.

Sirappa MP. 2003. Prospek pengembangan sorgum di Indonesia sebagai komoditas alternative untuk pangan. pakan. dan industry. Jurnal Litban Pertanian. 22:133-140.

Soeranto H, Sihono, Parno. 2011. Application of mutation techniques in sorghum breeding for improved drought tolerance. J Agron Indon.

Subagio H, Aqil M. 2014. Perakitan dan pengembangan varietas unggul sorgum untuk pangan. pakan dan bioenergy. IPTEK Tanaman Pangan. 9:39-50.

Suminar R, Suwarto, Purnamawati H. 2017. Penentuan dosis optimum pemupukan N. P. dan K pada sorgum (*Sorghum bicolor* [L.] Moench). J Ilmu Pertanian Indonesia. 22:6-12.

Surya IM. Soeranto H. 2006. Pengaruh iradiasi sinar gamma terhadap pertumbuhan sorghum manis (*Sorghum bicolor* L.). Risalah Seminar Ilmiah Aplikasi lsofop dan Radiasi. p. 209-215.

Tsuchihashi N, Goto Y. 2008. Year-round cultivation of sweet sorghum (*Sorghum bicolor* (L.) Moench) through a combination of seed and ratoon cropping in Indonesia savanna. Plant Prod. Sci. 11:377-384.

Widyastuti Y, Rumarti IA, Satoto. 2012. Perilaku pembungaan galur-galur tetua padi hibrida. IPTEK Tanaman Pangan. 7:67–78.