Effects of Plant Growth Promoter on Growth Response and Yield of Several Sorghum Varieties in Sukoharjo

Ferdifta Wahyu Anggita[1], *Puji* Harsono[1,2,*], and *Amalia* Tetrani Sakya[1,2]

[1] Master Program of Agronomy, Faculty of Agriculture, Sebelas Maret University, Jl. Ir. Sutami No. 36, Jebres, Surakarta, Central Java, Indonesia
[2] Departement of Agrotechnology, Faculty of Agriculture, SebelasMaret University, Jl. Ir. Sutami No. 36, Jebres, Surakarta, Central Java, Indonesia

Abstract. *Sorghum bicolor* is a C4 crop and cereal that is drought tolerant. Sorghum cultivation has several advantages because it requires very little agricultural input. Sukoharjo Regency has dry land and grumusol soil types located in areas with limited water sources, with physical properties of the soil being hard when dry. The experiment is randomized block design with 2 treatment factors. The first treatment was varieties of sorghum (V1=Numbu, V2=Super 1, V3=Suri 3, V4=Keller, V5+Kawali, V6=Black Sorghum, and V7=Bioguma 2). The second treatment was a type of plant growth promoter (no treatment, Auxin 10 ml.L^{-1} and Gibberellins 10 ml.L^{-1}) and was repeated 3 times. The observation variables as plant height 6 weeks after planting, number of leaves 6 weeks after planting, stem diameter 4 weeks after planting, and seed weight per plans. The result showed the interaction between varieties and applications of plant growth promoter on the number of leave. Bioguma 2 and Super 1 variety had a significant effect on plant height and seed weight per plant.

1 Introduction

Agricultural development is related to regional development, especially in rural areas which are closely associated with efforts to increase the income and welfare of the agricultural community. In realizing food security in the village, agricultural development needs strategic steps from a production approach to an agribusiness-based approach. In reducing dependence on imported food, it is necessary to develop local food ingredients that can be cultivated on dry land and have the potential to substitute rice as a staple food [1].

Sorghum (*Sorghum bicolor* (L.) Moench) Sorghum is one of the potential cereal crops to be developed in dry land or marginal land [2] because it has wide adaptability. The water requirement of sorghum is relatively low compared to corn, which is 400 – 450 mm [3] and resistant to pests and diseases of sorghum [4] and can be ratooned up to 2 -4 times [5]. Sorghum is a zero-waste plant where all parts of the plant can be utilized such as seeds, flowers, leaves, stems, sugar of stems, and roots. Sorghum can be used as healthy food, forage, and material of bio-ethanol [6]. For Indonesia, within the next 6 – 15 years (2020 –

* Corresponding author: pharsono61@gmail.com

2030) sorghum can be developed as a staple food supplementation of rice and a component of feed rations, this will be a revival of the sorghum crop which has been abandoned so far [7].

Sorghum is resistant to drought stress[8]. However, plants that are truly suitable for cultivation in Sukoharjo dry land have not been obtained. Therefore, several components of sorghum production technology must be considered and implemented as a whole to achieve the expected productivity, such as the use of high-quality varieties [9] and application of plant growth promoter as auxins and gibberellins to stimulate plant growth.

Auxins and gibberellins are used in plant physiology studies and plants respond well to plant growth promoter. Stable Auxin and Gibberellins can stimulate plant growth and the development of plant [10]. Auxin and Gibberellins are the keys to success in seed production. Auxin can increase panicle from flag leaf, increase stigma level and regulate plant height [11].

2 Materials and method

2.1 Materials and Method

This research was conducted in January until Mei 2021 in Cabeyan District, Sukoharjo Regency. The planting material used in this study consisted of 7 varieties of sorghum including V1=Numbu, V2=Super 1, V3=Suri 3, V4=Keller, V5=Kawali, V6=Black Sorghum, V7=Bioguma 2, and Plant Growth Promoter Auxin, and Gibberellins. This experiment used a factorial Completely Randomized Block Design with two treatment factors and was repeated 3 times. The first factor is seven varieties of sorghum, and the second factor is the type of plant growth promoter auxin and gibberellins without treatment, Auxin 10 ml.L^{-1} water and Gibberellins 10 ml.L^{-1} water.

2.2 Data Analysis

The observation variables as plant height 6 weeks after planting, number of leaves 6 weeks after planting, stem diameter 4 weeks after planting, and seed weight per plant. The data obtained will be analyzed using a 5% ANOVA test. If the treatment has a significant effect, followed by 5% level of Duncan's Multiple Range Test (DMRT). Data analysis using SPSS version 26 software.

3 Result and discussion

The analysis of variance showed that there was an effect of seven varieties of sorghum used on plant height 6 weeks after planting and seed weight per plant. As presented in Table 1.

Table 1. Effect of variety on plant height and seed weight per plant.

Treatment	Plant heigh (cm)	Seed weight per plant(g)
V1 (Numbu)	184.72 b	168.69 de
V2 (Super 1)	186.98 b	188.10 f
V3 (Suri 3)	183.98 b	138.82 bc
V4 (Keller)	199.64 c	108.50 a
V5 (Kawali)	183.51 b	154.65 cd
V6 (Black sorghum)	130.90 a	125.27 ab
V7 (Bioguma 2)	184.75 b	195.06 f

Remarks: Same letter in the same column and row shows results that are not significantly in the Duncan's test (a = 5%).

Based on the results of the Duncan 5% test (Table 1), the Keller variety had the highest plant height yield than other varieties. The Keller variety was 68.74 cm taller than the Black Sorghum variety and 14.89 cm taller than the Bioguma 2 variety. The varieties of Super 1 were 2.23 cm taller than the Bioguma 2 variety but did not show a significant difference in height. The duncan's test showed that genetically of Keller varieties had a higher morphology than the Numbu varieties. Differences height of plant are influenced by gene (internal factors) and hormones in the plants [12].

The shape and size of the seeds of the seven varieties of sorghum used showed different results and affected the weight of seeds per sorghum plant. The Bioguma 2 varieties a higher seed weight per plant than other six varieties because each variety had different characteristics. The research result of [13] that seed weight is associated with increased plant growth and development in absorbing nutrients during the vegetative period. If the vegetative growth of plants is low, seed formation will be inhibited. If the rate of photosynthesis of plants is different, the amount of assimilating produced is also different[14], as well as seed weight which is a reflection of the rate of plant growth.

Leaves are organs that contain chloroplasts and are useful in the process of photosynthesis. The number of leaves is an indicator of growth and supports explaining the process of formation of plant biomass[15]. Based on the 5% Duncan's test which is presented in Table 2 there is an interaction between the seven varieties of sorghum and the application of various growth promoters on the number of leaves.

Table 2. The Interaction of sorghum varieties and types of growth promoter on the number of sorghum leaves

Treatment	Plant growth promoter		
	Z0 (Without treatment)	**Z1 (Auxin)**	**Z2 (Gibberellin)**
Number of leaves			
V1 (Numbu)	12.00 bcdefg	11.33 bcd	13.11 fg
V2 (Super 1)	12.44 cdefg	10.88 b	13.22 g
V3 (Suri 3)	12.22 cdefg	12.55 defg	11.77 bcde
V4 (Keller)	12.33 cdefg	12.88 efg	12.77 efg
V5 (Kawali)	12.22 cdefg	11.22 bc	11.88 bcdef
V6 (Black Sorghum)	8.11 a	8.11 a	8.55 a
V7 (Bioguma 2)	12.44 cdefg	10.77 b	13.22 g

Remarks: The number followed by the same letter in the same row and column shows results that are not significantly in the Duncan's test (a = 5%)

Based on the results of the Duncan 5% test, there was an interaction between varieties and the application of growth promoter auxin and gibberellins. The Seper 1 and Bioguma 2 variety with gibberellin treatment gave the highest number of leaves is 13.22 pieces. Black Sorghum varieties without treatment and with treatment of plant growth promoter auxin and gibberellin gave the same number of leaves is 8.11 pieces. The research result of [16] explained that the number of sorghum leaves correlated with the length of the vegetative period, as evidenced by each addition of one leaf it took 3-4 days. The Keller variety has a longer vegetative period than the Numbu and Kawali varieties [17]. The more the number of leaves, the photosynthetic process will increase which is followed by an increase in cell activity in division, enlargement, and elongation. This is in accordance with the statement [18] that auxin plays a role in the absorption of N, Mg, Fe, and Cu in the cell wall which will form photosynthetic so that it affects the growth and number of leaves.

The Plant stems develop very quickly during the vegetative period. The stem uses some of the carbohydrates formed by plants for the development of cells in the cortex and vascular

system, resulting in an increase in stem diameter. The stem diameter provides information on the relationship of water, carbon and plant nutrients [19].

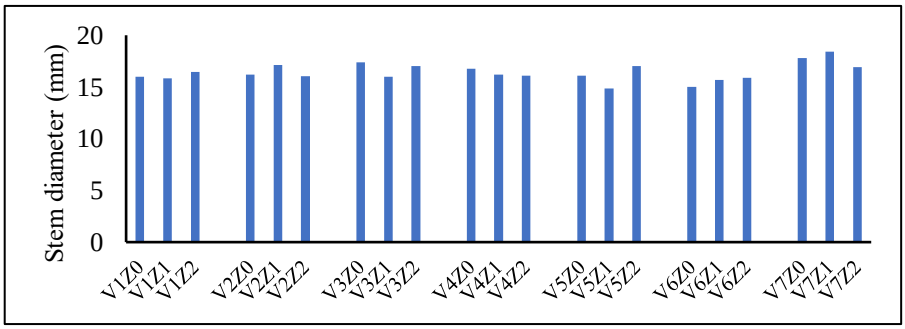

Fig. 1 Seven varieties of sorghum and the application of plant growth promoter on stem diameters 4 weeks after planting.

The ANOVA showed the seven variety of sorghum, and the application of growth promoter did not affect the stem diameter of sorghum and there was no interaction between the varieties of sorghum and the application of plant growth promoter auxin and gibberellins (Figure 1). The results of this study are similar to previous studies [20] that there was no difference in stem diameter in the sorghum development phase. This is because, in the early phase of sorghum growth, it is the rainy season with very high rainfall, it is suspected that sorghum experiences waterlogging which affects its growth characteristics, including stem diameter.

4 Conclusion

Based on the results of the experiment, it can be concluded that the Sorghum variety Bioguma 2 with the application of growth promoter auxin and gibberellins can be applied to dry land in Sukoharjo. Variety of Bioguma 2 and Super 1 is very potent and can be used as food and animal feed.

References

1. B. Irawan and N. Sutrisna, “Prospek Pengembangan Sorgum di Jawa Barat Mendukung Diversifikasi Pangan.” pp. 99–113, (2011).
2. A. F. G. Uran, P. S. Agroteknologi, F. Pertanian, U. Flores, and J. S. Ratulangi, “Kajian Agronomi Potensi Pengembangan Tanaman Sorgum Varietas Numbu di Kabupaten Ende Agronomic Study on the Potential Development of Numbu Sorghum Variety in Ende Regency,” **17**, 1, pp. 23–27, doi: 10.30598/jbdp.2021.17.1.23 (2021).
3. S. A. Ouda, A. M. Taha, and M. M. Ibrahim, “Water management for maize grown in sandy soil under climate change conditions,” Arch. Agron. Soil Sci.. **61**, 3. pp. 299–311, doi: 10.1080/03650340.2014.935936 (2015).
4. S. Mas’ud, “Perkembangan Serangga Aphis pada Beberapa Galur/Varietas Sorgum di Maros,” in *Seminar Nasional Serealia 2011*, pp. 513–516 (2011).
5. R. Z. A. Al-beiruty, A. S. Al-rawi, and S. H. Cheyed, “Effect of ratoon cropping of sorghum cultivars on the tillering contributing on the forage and grain yield,” J. Iran. Soc. Ichthyol. **1**,1, pp. 83–87, (2022).
6. P. G. Adinurani, S. Rahayu, and L. S. Budi, “Potensi Kadar Nira dan Produksi Beberapa Varietas Sorgum Manis (Sorghum vulgare) di Lahan Kering Area Hutan sebagai Bahan Baku Bioetanol,” J. AGRI-TEK J. Penelit. Ilmu-Ilmu Eksakta, **20**, 1, pp. 23–27, doi:

10.33319/agtek.v20i1.51 (2019).

7. Sumarno, D. Damardjati, M. Syam, and Hermanto, "Sorgum Inovasi Teknologi dan Pengembangan," in *Sorgum Inovasi Teknologi dan Pengembangan*, Maros: IAARD Press, (2013).
8. S. Hossain, N. Islam, and M. Rahman, "Sorghum : A prospective crop for climatic vulnerability , food and nutritional security," J. Agric. Food Res., **8**, 1 doi: 10.1016/j.jafr.2022.100300 (2022).
9. A. Lokal, L. Kecamatan, B. Kabupaten, and L. Utara, "Revitalisasi Usahatani Sorgum Daerah Lahan Kering Untuk Konsumsi Pangan Jurnal PEPADU Revitalisasi Usahatani Sorgum Daerah Lahan Kering Untuk Konsumsi Pangan Alternatif Lokal di Desa Loloan Kecamatan Bayan Kabupaten Lombok Utara," no. July, doi: 10.29303/jurnalpepadu.v1i3.112 (2020).
10. Z. Rashid *et al.*, "Influence of Plant Growth Regulators and Micronutrients on Growth, Yield and Quality of Sorghum under Temperate Conditions," J. Exp. Agric. Int., **43**, 9, pp. 18–23, doi: 10.9734/jeai/2021/v43i930732 (2021).
11. M. K. Bangun, Z. Siregar, and R. Damanik, "Respons Pertumbuhan Beberapa Varietas Sorgum (Sorghum bicolor L.) Pada Tanah Salin Dengan Pemberian Giberelin," J. Agroteknologi, **4**, 3, pp. 1996–2002, (2016).
12. K. F. Hidayat, Sunyoto, and A. D. Saputro, "Pengaruh Kerapatan Tanaman dan Varietas Sorgum Terhadap Pertumbuhan dan Produksi Biomassa Sorgum pada Sistem Tumpangsari Sorgum dengan Ubikayu," *Semin. Nas. Dalam Rangka Dies Natalis UNS Ke 42*, **2**, no. 1, pp. 336–345, (2018).
13. D. Irawan, C. Ezward, and D. Okalia, "Pengaruh Pemberian Pupuk Kotoran Kerbau Dan Pupuk Urea Terhadappertumbuhan Dan Produksi Sorgum (*Sorghum bicolor* (L.) Moench)," J. Green Swarnadwipa, **9**,1, pp. 46–57, (2020)
14. E. Borghi *et al.*, "Sorghum grain yield , forage biomass production and revenue as affected by intercropping time," Eur. J. Agron., **51**, pp. 130–139, doi: 10.1016/j.eja.2013.08.006 (2013).
15. F. Xu *et al.*, "The ratoon rice system with high yield and high efficiency in China: Progress, trend of theory and technology," F. Crop. Res., **272**, 1, p. 108282, doi: 10.1016/j.fcr.2021.108282 (2021).
16. A. Nur and K. Syahruddin, "Pengaruh Radiosensivisitas Iradiasi Sinar Gamma Terhadap Perkembangan Kecambah Dan Pertumbuhan Vegetatif Tanaman M1 Sorgum Manis (Sorghum bicolor L .)," in *Prosising Seminar Nasional Serealia 2015*, pp. 131–139 (2015).
17. F. W. Anggita, P. Harsono, R. Wijayanti, and S. Supriyono, "Keragaan beberapa Varietas Sorgum terhadap Aplikasi Kitosan Iradiasi," Agrotechnology Res. J., **5**, 2, pp. 63–68, doi: 10.20961/agrotechresj.v5i2.45095 (2021).
18. W. Wulansari, A. Rosyidah, and S. Muslikah, "Pengaruh Pemberian Zpt Giberelin Dan Auksin Terhadap Pertumbuhan Dan Hasil Stek Tanaman Kentang Varietas Granola Arjuno (Solanum tuberosum L.)," J. Agronisma, **9**, 1, pp. 9–19 (2021).
19. A. Beiruty, R. Z. A., Al-Rawi, A. S., & Cheyed, S. H. Effect Of Ratoon Cropping Of Sorghum Cultivars On The Tillering Contributing On The Forage And Grain Yield. Journal Iranian Society Of Ichthyology, 1, P. 83–87 (2022).
20. K. B. Abreha, Enyew, M., Carlsson, A. S., Vetukuri, R. R., & Feyissa, T. Sorghum In Dryland : Morphological , Physiological , And Molecular Responses Of Sorghum Under Drought Stress. Planta, **255**, 1, P. 1–23. Https://Doi.Org/10.1007/S00425-021-03799-7 (2022)**.**