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Effect of planting spaces and fertilization package on the productivity and prolific level of maize var. Sinhas 1

To cite this article: Muh. Farid *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **807** 042042

Effect of planting spaces and fertilization package on the productivity and prolific level of maize var. Sinhas 1

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Abstract. A study aimed to determine planting system and fertilization packages that give the best result on productivity and prolific level of Maize was conducted. Maize variety Sinhas 1 was planted with three planting systems to design different planting spaces between and within the rows. A Legowo planting system was used with two models, ie. Legowo (50+100) x 20 cm and Legowo (50+100) x 18 cm, resulted in a total of 66,667 and 74,074 population per hectare, respectively. A normal planting spacing of 75 x 20 cm was used as control with a total population of 66,667 plants per hectare. Four fertilization packages were used consisted of N:P:K= 225:100:75; N:P:K= 200:100:60 + KNO_3 10 kg; N:P:K= 225:100:75 + Ecofarming 5cc/L; and N:P:K= 200:100:50 + KNO_3 10 kg + Ecofarming 5 cc/L. A split plot experimental design was employed. Results show that Legowo planting system and fertilization packages significantly increased the productivity and the prolific level of the maize. Planting density of Legowo (50+100) x 20 cm applied with N:P:K = 200:100:50 + KNO3 10 kg + Ecofarming 5cc/L resulted in the highest productivity of 10.43 t ha^{-1} with percentage of prolific of 73.36%.

1. Introduction

Corn (*Zea mays* L.) is one of the most popular cereals in the world and is a staple food in many countries including the United States. Corn is not only a food source to provide the necessary calories for the body's metabolism, but is a rich source of vitamins A, B, E and many minerals. Besides being used for food, corn is also cultivated as animal feed (leaves and cobs), oil is taken (from seeds), made flour (from seeds, known as corn flour or corn starch), and industrial raw materials (from seed flour and cob flour).), and plays a strategic role in the national economy as one of the main commodities in agribusiness. Its wide use in various industries causes the need for corn to increase.

In 2018, production data reached 5.24 t / ha and harvested area reached 5.73 million ha. This data is considered to have increased production by 3.64% and harvested area by 5.66%, thus increasing national productivity by 0.27% [1]. However, this production has not been able to meet domestic demand for corn, so imports are a solution to address domestic demand for corn. Corn breeding efforts in Indonesia have succeeded in creating the Sinhas 1 variety. The Unhas Synthetic maize variety (SINHAS 1) has been released by the Ministry of Agriculture of the Republic of Indonesia with Decree Number: 484 / HK.540 / C / 10/2019 (research collaboration between Unhas and Balitsereal Maros) has a yield potential of 10.71 t.ha^{-1} with an average yield of ± 7.82 t.ha^{-1}, yields under drought stress conditions of ± 6.27 t.ha^{-1}, yields under low nitrogen stress conditions ± 6.41 t.ha^{-1}, and the yield on a combination of drought stress and low nitrogen ± 4.75 t.ha^{-1}. These yields can still be improved if cultivated optimally according to the nutrient needs and environment of each corn variety. Sinhas 1 corn is the first Unhas maize variety product and has been researched by Muh. Farid and Yunus Musa for 6 years from 2013 to 2019 and have received a distribution permit under the name of SINHAS 1.

High genetic potential can only be obtained if environmental conditions support growth and production. Setting the distance between the plants and the fertilizer package are two factors that can provide a real interaction in light reception and good nutrient absorption. The legowo planting system has become one of the technological components in integrated crop management (PTT) in rice [2]. The legowo system has not yet been included in the corn PTT technology component. However, the research results of Zubactirodin et al. [3] showed that the maize yields obtained from the same planting population with legowo spacing were greater than the usual spacing with yield increases ranging from 2.5-20%. The plant population needs to be considered because a high population can reduce the yield of maize. Plants with large crowns require a loose spacing to prevent overlapping which results in plant competition against light [4]. Lawer and Rankin [5] reported that increasing the maize crop population to 74,000 plants / ha decreased the seed yield by 18%. Therefore, an increase in plant population needs to be regulated by a planting system that can reduce light competition and competition for nutrients between plants. The 2: 1 legowo system is a cropping model that places all plants as edge crops, so that even if the population is increased, it does not interfere with the absorption of light by the plants. To avoid competition for nutrients in plants, it is necessary to look for 2: 1 spacing for legowo and optimal fertilization packages that can increase secondary cobs formation in prolific maize, so that the resulting productivity can reach 12.5 $t.ha^{-1}$.

Apart from selecting superior varieties and fertilizers, the production technology that we can apply is determining the optimal plant population to increase maize production. Spacing can optimize the use of environmental factors in terms of competition for nutrients and light, so that an increase in plant population per unit area can increase seed yields [6]. On the other hand, a reduction in maize density per hectare can result in microclimate changes that affect growth and yield.

Spacing technology is needed to obtain optimal population levels; make it easier to maintain; get additional feed effect (on legowo row planting); reduce competition for nutrients between plants and maximize sunlight reception to plants so that the photosynthesis process can be maximized. One of the technological innovations in spacing is planting legowo rows. Jajar legowo is a planting method designed to increase plant productivity through increasing plant populations and utilizing the crop edge effect. Utilization of the legowo system is associated with efforts to increase production through increasing the planting index (IP) of maize. With an increase in IP, yields can increase and land management becomes more productive.

A high population increase will have implications for different nutrient requirements, so a balance is needed between the number of population and the dose of fertilization applied. The concept of balanced fertilization is carried out by referring to the creation of a balance of macro nutrient elements in the soil so that plants can produce optimally. The ratio between the elements N: P: K will determine the ability of maize plants in genetic expression to produce cobs prolific optimally, so that the resulting prolific percentage is higher. In order for optimal yield potential, additional organic fertilizers are needed as additional nutrients in the form of biological fertilizers such as the use of eco farming. Therefore it is necessary to study the response of the new variety released under different population densities and fertilization packages to obtain the best package for optimal production and prolific level of maize variety of Sinhas 1.

2. Methodology

Maize variety Sinhas 1 was planted with three planting systems to design different planting spaces between and within the rows. A Legowo planting system was used with two models, ie. Legowo (50+100) x 20 cm and Legowo (50+100) x 18 cm, resulted in a total of 66,667 and 74,074 population per hectare, respectively. A normal planting spacing of 75 x 20 cm was used as control with a total population of 66,667 plants per hectare. Four fertilization packages were used consisted of N:P:K= 225:100:75; N:P:K= 200:100:60 + KNO_3 10 kg; N:P:K= 225:100:75 + Ecofarming 5cc/L; and N:P:K=

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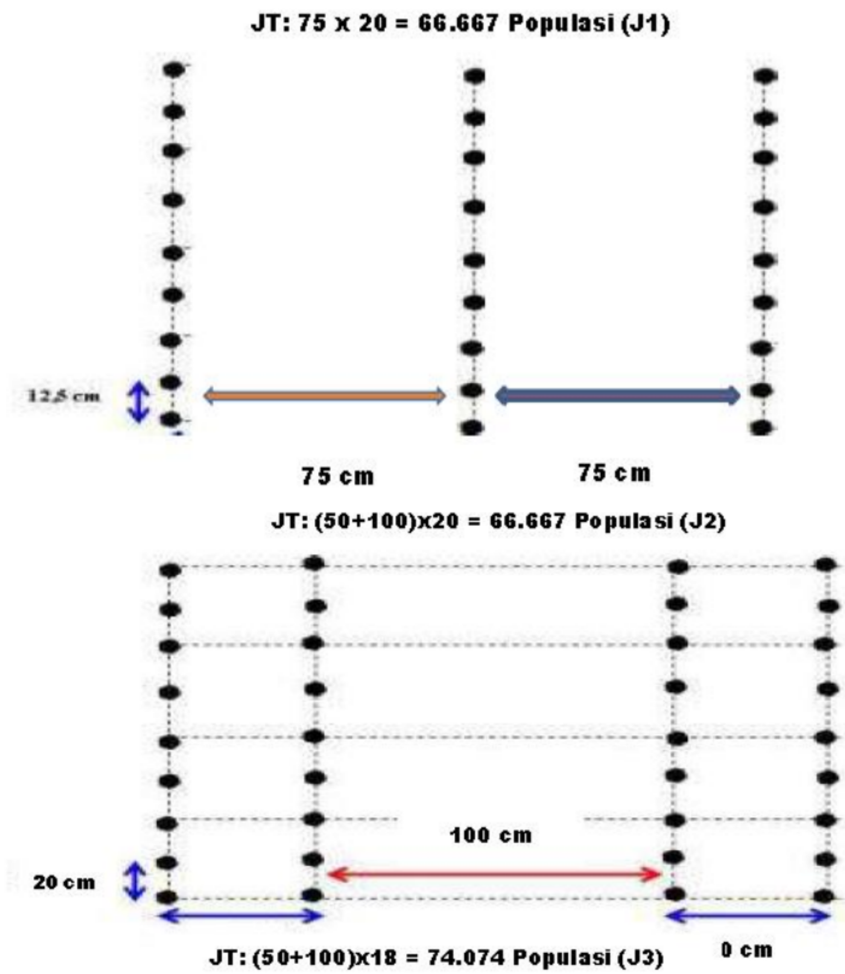
200:100:50 + KNO_3 10 kg + Ecofarming 5 cc/L. A split plot experimental design was employed with the legowo planting system (S) set as the main plot while the sub plot was the fertilizer package / ha (P).

Soil cultivation is carried out by perfect tillage, then a plot measuring 3.5 m x 5 m is made. Each treatment was planted 5 rows on each experimental plot with the legowo spacing according to the treatment. Burial planting with two seeds / planting hole and closed using compost 1.7 kg / plot (3 ton.ha-1). Fertilization is carried out three times according to the treatment. The legowo planting system is shown in figure 1.



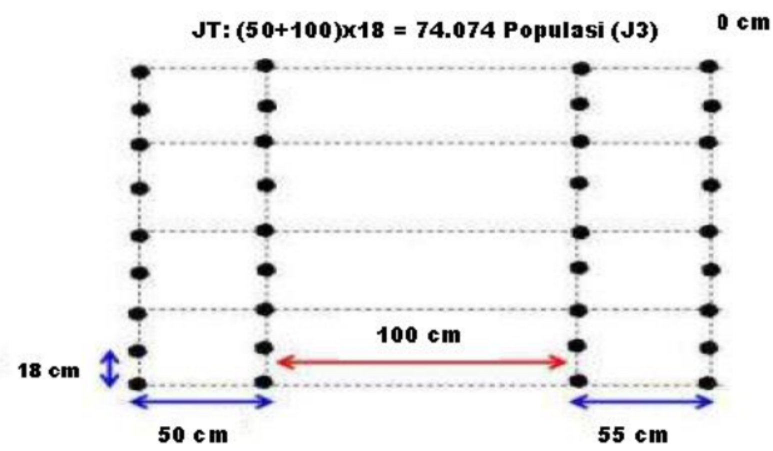


Figure 1. Layout of Legowo planting system with different spacing between and within the row and the total population of maize. J1 is normal planting distance.

Spraying Eco farming is given five times, namely 2 days before planting, 10 days after planting (DAP), 30, 50, and 70 DAP. Urea, NPK Ponska and KNO_3 were given three times, namely at the age of 7, 35, and 50 DAP, except SP36 was only given once at the age of 7 DAP. Weeding is done by clearing the weeds around the plants, while stocking is done by elevating the ridges and loosening the soil to create better soil aeration. The first weeding is done before the second fertilization, while the stocking is done after the second fertilization. Harvesting is done when the plants are physiologically ripe, which is indicated by the appearance of a black coating on the back of the seeds. Harvesting was done manually in the middle two rows of plants per number then processed to observe yield and yield components. The parameters observed were growth and yield components. Data analysis was performed by analysis of variance followed by the smallest significant difference test at the 95% confidence level.

3. Results and discussion

3.1. Effect of planting density and fertilization packages on plant growth

Planting system did not significantly affect the plant growth. On the other hand, leaf development was varied significantly with the combination of fertilization applied while plant and ear height were not affected by both treatments. Despite this, arranging the planting system using Legowo with narrower spaces within the row, such as shown in figure 1, increased the plant height and the position of the primary ear compared to normal planting distance (figure 2).

The Legowo planting system provide an extra spaces for radiation absorption as plants exposed more to the sunlight. A study conducted by Heniwati et al. [7] also showed the insignificant effect of the planting system on the parameter, but resulted in slightly higher plant in the narrower spaces between rows. In this recent study, fertilization applied in the form of NPK, KNO_3, and Ecofarming fertilizer might also play role in affecting soil nutrition therefore can increase the plant height. The availability of nutrients will accelerate the process of plant metabolism, hence will affect plant height. The higher the plant will increase the efficiency of light absorption by the plant itself. Sutedjo and Kartasapoetra [8] also revealed that the availability of more soil N elements can produce more protein, the higher the nitrogen administration, the faster the synthesis of carbohydrates is converted into protein and protoplasm.

Ear height is one of important characters that can be attributed to plant height. The results show that Legowo planting system resulted in higher ear height compare to normal planting space (figure 2). In the normal planting system, ear was observed to be at the lower position compare to maize plants planted in Legowo planting system. The location of the cobs in maize is closely related to the plant's height. The higher the plant, the higher the location of the cob. Spacing is an effort made to optimize the growth and development of maize plants. Spacing is one way to make the factors needed by plants available to each plant and optimize the use of available environmental factors [9]. Spacing is closely related to the morphological character of plants. As a result, the population density is too high, it will cause plants to grow abnormally. Spacing will affect the density and efficiency of light use, competition for plants in the use of water and nutrients so that it will affect crop production [10]. Arrangement of spacing greatly affects plant growth and yield [11].

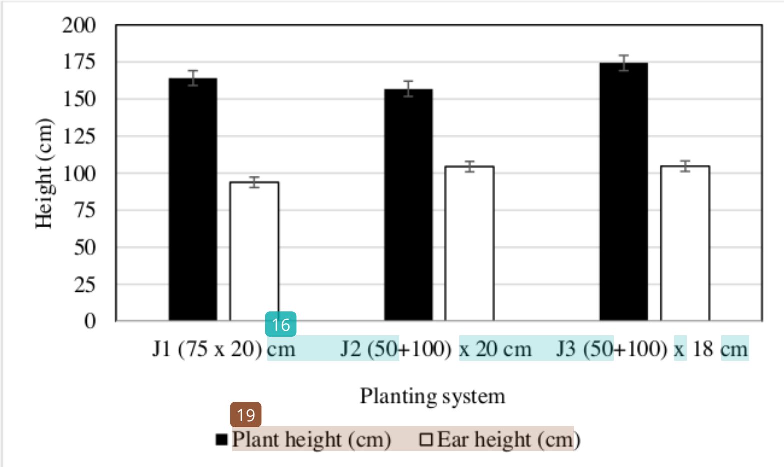


Figure 2. Plant height and ear height of maize var. Sinhas 1 at different planting system

Leaf development of the maize Sinhas 1 variety was significantly improved by the use of complete composition of NPK, KNO_3 and Ecofarming ferlitization package rather than using a single type of NPK fertilizer (table 1). Giving the right dose of fertilizer to plants accelerates the photosynthesis process of carbohydrates into protein for plants which is useful for plant growth and development. Plants with higher N content generally have wider and greener leaves, thus accelerating the photosynthesis process with good light reception. According to Sahari [12], the higher the photosynthate produced, it is assumed that the higher the translocated photosynthate so that the dry weight of the plant increases.

Table 1. Effect of fertilization packages on leaf development of Maize var. Sinhas 1.

Fertilization packages	Number of leaves (leaves)	Leaf area (cm^2)	Number of stomata (stomata/mm^2)
P1 (N:P:K= 225:100:75)	11.37 b	47.02 b	10.63 bc
P2 (N:P:K= 200:100:60 + KNO_3 10 kg)	11.56 b	52.88 a	10.44 c
P3 (N:P:K= 225:100:75 + Ecofarming 5cc/L)	12.19 a	52.45 a	11.74 ab
P4 (N:P:K= 200:100:50 + KNO_3 10 kg Ecofarming 5 cc/L)	12.15 a	54.02 a	12.00 a

Numbers followed by different letters in columns (a, b, c) mean significantly different at the $LSD_{0.05}$ test level.

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The number of leaves on the amount of sunlight energy absorption to the plant. The growth in leaf area is influenced by the amount of nitrogen that plants can absorb. Lakit [13] reported that the nutrient that had the most influence on leaf growth and development was nitrogen. Leaf area correlates with the amount of sunlight energy infiltration into the plant. The growth in leaf area is influenced by the amount of nitrogen that plants can absorb. The nitrogen content contained in the soil will be utilized by maize plants in cell division. The cell division of the three layers of the outer cells on the end surface of the stem divided by young enlarged cells will form leaf primordial. Application of fertilizer to plants will show an effect on the stomata openings and also the water potential. Potassium plays a role in stomata opening and transport, increases leaf water potential, increases the ability of plants to absorb water from the soil, plays a role in water uptake by roots, and regulates the movement of water from root cells to xylem tissue [14].

3.2. Effect of planting density and fertilization packages on yield components

Analysis of variance results show that there was a significant interaction between planting system used and fertilization packages applied on the yield component and prolific levels of maize. Use of Legowo planting system increased plant productivity and prolific level of maize (table 2 and 3). Similarly, fertilization packages that contain KNO_3 and Ecofarming fertilizer also resulted in higher yield and produced more secondary ears. Table 2 and 3 show that compared to normal planting distance and the use of single NPK fertilizer, maize planted using Legowo (50+100) x 20 cm and applied with combination of N:P:K= 200:100:50 + KNO_3 10 kg + Ecofarming 5 cc/L resulted in the highest productivity (10.43 t/ha) and prolific level of 73.36%.

Table 2. Effect of planting system and fertilization packages on the productivity (t/ha) of Maize.

Planting System	Fertilization Packages				Ave
	P1	P2	P3	P4	
J1 (75 x 20)	9.05a^{pq}	8.09a^{q}	9.84a^{p}	9.05a^{pq}	9.01
J2 (50+100) x 20 cm	9.29a^{p}	9.87a^{p}	9.61a^{p}	10.43a^{p}	9.80
J3 (50+100) x 18 cm	7.27b^{q}	9.76b^{p}	9.09a^{p}	10.25a^{p}	9.69
Ave	8.53	9.24	9.51	9.91	

Numbers followed by different letters in columns (a, b) and rows (p, q)mean significantly different at the $LSD_{0.05}$ test level. P1 : N:P:K= 225:100:75; P2 : N:P:K= 200:100:60 + KNO3 10 kg; P3 : N:P:K= 225:100:75 + Ecofarming 5cc/L; P4 : N:P:K= 200:100:50 + KNO3 10 kg + Ecofarming 5 cc/L.

Table 3. Effect of planting system and fertilization packages on the prolific level (%) of Maize.

Planting System	Fertilization Packages				Ave
	P1	P2	P3	P4	
J1 (75 x 20)	42.08^{r}	60.30^{p}	69.08^{p}	56.10^{q}	56.89
J2 (50+100) x 20 cm	67.65^{p}	68.31^{p}	66.47^{p}	73.36^{p}	68.95
J3 (50+100) x 18 cm	58.05^{r}	72.13^{p}	66.86^{pq}	62.00^{qr}	64.76
Ave	55.93	66.91	67.47	63.82	

Numbers followed by different letters mean significantly different at the $LSD_{0.05}$ test level. P1 : N:P:K= 225:100:75; P2 : N:P:K= 200:100:60 + KNO3 10 kg; P3 : N:P:K= 225:100:75 + Ecofarming 5cc/L; P4 : N:P:K= 200:100:50 + KNO3 10 kg + Ecofarming 5 cc/L.

Production is an important benchmark that determines the success of a research carried out, be it production per plot or production per hectare. Appropriate fertilization and variety response to a given treatment will result in high production [15]. The use of superior varieties has advantages compared to local varieties in terms of production and resistance to pests and diseases, fertilization response so that the production obtained in both quantity and quality can increase [16]. Sutedjo [17] also stated that plants will not give maximum results if the nutrients needed are not available. The gene potential of a plant will be optimal if it is supported by environmental factors that play a role in the appearance of the characters in the gene [18]. According to Syafruddin et al. [19], good adaptation to the environment will affect crop production or yield.

4. Conclusion

The treatment of the Legowo planting system (50 + 100) x 20 cm with the fertilizer package of N:P:K= 200:100:50 + KNO_3 10 kg + Ecofarming 5cc / L gave the highest maize productivity (10.43 $t.ha^{-1}$) with a prolific percentage 73.36%.

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