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Properties of Rooting, Growth and Yield of Corn (*Zea mays* L) at Various Watering Intervals

Angela Patricia Kerawing, Sri Suryanti*, Setyastuti Purwanti
Institut Pertanian STIPER,
Jl. Nangka II, Maguwoharjo, Sleman, Yogyakarta,
*Email: ntie@instiperjogja.ac.id

ABSTRACT

Limited water availability, particularly during the grain filling period, is a significant factor that affects the low production of corn. The root system plays a crucial role in adapting to water scarcity conditions. Hence, a study was conducted to investigate the impact of different watering intervals on the rooting properties, growth, and yield of corn plants. This research took place at the INSTIPER Yogyakarta experimental and research garden in Sempu Village, Wedomartani, Ngemplak District, Regency Sleman, Yogyakarta, from March 2023 to July 2023. The experimental design employed was a Completely Randomized Design (CRD) with a single factor, consisting of three watering treatments: once a day, once every 2 days, and once every 7 days. The parameters observed included rooting, growth, and yield. The findings revealed that the watering interval of every 7 days resulted in increased root length and a decrease in the number of leaves. Although the 7-day watering interval led to a decrease in the number of cobs, it did not affect cob length, cob diameter, cob weight with husks, cob weight without husks, and weight per 100 seeds.

Keywords: *Root, growth, yield, corn, watering interval*

1. INTRODUCTION

Corn (*Zea mays* L) is a significant food source, second only to rice, and its demand continues to rise in tandem with the growth of the corn processing industry and animal feed production. Despite the national corn production reaching 19.61 tons, the domestic demand stands at a staggering 25 million tons. Consequently, it becomes imperative to undertake measures to boost corn production (Azizah *et al.*, 2017).

In various parts of Indonesia, the rise in corn cultivation indicates a general decline in corn production. Concurrently, the population continues to grow, resulting in an increased demand for corn. Consequently, the disparity between the total national corn production and the required quantity has been progressively widening over the years. If this situation persists without intervention, the importation of corn will escalate, leading to a heightened dependence on foreign nations for our country (Dewanto *et al.*, 2017).

Drought stress is a significant contributor to the decline in national corn production. Adequate water supply plays a vital role in facilitating the growth and development of plants. Different plant species have varying water requirements. Surplus water can interfere with the photosynthesis process, thereby impeding carbohydrate production. Prolonged water scarcity can lead to critical alterations in plant structure, accounting for up to 75% of the impact when combined with other production factors like seeds and fertilizer. Additionally, excessive water can hinder plant growth, particularly in the root system, potentially causing root rot.

In general, farmers usually plant maize during the dry season on paddy fields after two rice cultivations, and also on moorland during the rainy season, potentially experiencing water deficits. In order for maize plants to have good and high production, they need sufficient irrigation and wider roots. Yield reductions range from 21% to 40% when maize plants are water deficit, with kernel weight being the most affected component. The kernel filling period becomes 8 days shorter when water deficiency occurs. In times of water shortage, roots play an important role in plant adaptation because they are able to absorb water by maximizing the root system. Some of the root morphological characters that indicate plant resistance to water shortage are root elongation into deeper soil layers, increased root system breadth and depth, expanded horizontal and vertical root distribution, greater root dry weight in more drought-tolerant genotypes, increased root volume, increased root specific gravity and longitudinal resistance in roots, high root penetrability, higher root to crown ratio and root length to plant height ratio (Nio & Torey, 2013), increasing root biomass (Brunner et al., 2015) and changing root architecture (Kang, Peng and Xu, 2022). The results of research conducted by (Dato, Arsa and Kasim, 2023) showed that the watering interval treatment of 2 and 3 days significantly increased the number of leaves of corn plants at 14 days after planting, stem diameter, ear length, ear diameter and fresh weight. cob. It is not yet known the effect of watering intervals of up to 7 days on the roots, growth and yield of corn plants. Therefore, it is necessary to conduct research on the rooting, growth and yield of corn plants with watering intervals of up to 7 days.

2. MATERIAL AND METHODS

The study employed a single factor experimental approach, utilizing a completely randomized design (CRD). Three different watering treatments were implemented, namely watering once a day, watering every two days, and

watering once every seven days. The research was conducted at the INSTIPER Yogyakarta experimental and research garden, located in Sempu Village, Wedomartani, Ngemplak District, Regency Sleman, Yogyakarta. The study duration spanned from March 2023 to July 2023. The experimental site is situated at an elevation of 118 meters above sea level, with coordinates -7.76113,110.42460. The materials used were regosol soil, NPK fertilizer at a dose of 5 grams per polybag and corn seeds of the BISI 18 variety. The tools used in this research were polybags measuring 40 cm x 40 cm, *Paranet*, hoe, sieve, stationery, ruler to measure length. roots, measuring cups, scales. Watering the plants is done manually in the afternoon using a watering can. Watering is carried out according to the treatment, namely once a day, once every 2 days, and once every 7 days, watering until field capacity. Watering treatment is carried out after the plants are 2 weeks after planting. Observation parameters included root length, root volume, plant height, number of leaves, number of ears, ear length, ear diameter, weight of ear with husk, weight of ear without husk, weight of 100 seeds. The research data were analyzed using 5% analysis of variance and continued with further Duncan's Multiple Range Test (DMRT) and correlation analysis.

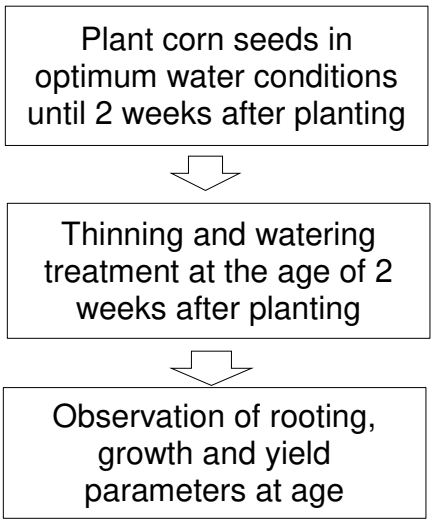

Figure 1. Research Stage

3. RESULT AND DISCUSSION

3.1 Rooting

According to the analysis findings, it is evident that there exists a notable disparity in root length parameters between watering once daily and watering every 7 days. The plants exhibit the longest roots when watered once every 7 days, whereas the shortest roots are observed when watered once daily. However, the volume of roots remains unaffected by the watering treatment. Regardless of whether the plants were watered every 1 day, 3 days, or 7 days, the root volume remained consistent. In response to water scarcity, plants tend to develop longer and wider roots as an adaptive measure to dry environmental conditions. This extended root growth aids in the search for water sources deeper within the soil. The Regosol soil, characterized by high porosity and low water retention capacity, can experience a significant reduction in moisture levels when watered once every 7 days. Consequently, the roots grow deeper to locate water sources, thereby enhancing

the corn plants' resilience against drought.

Table 1. Effect of watering interval on root length and root volume

Watering	Root Length (cm)	Root Volume (ml)
1 day	41.11 ± 0.05 c	113.33 ± 0.15 a
2 days	44.66 ± 0.12 b	111.11 ± 0.20 a
7 days	47.55 ± 0.07 a	120.00 ± 0.18 a

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different based on the DMRT test at the 5% level.

This research results are consistent with research conducted by (Wajhat-Un-Nisa et al., 2023) that the root length of corn plants is related to the resistance of corn plants to drought. Under drought stress conditions, the corn root system adapts to drought by elongating and increasing fine roots to increase root water absorption (Yan et al., 2022). Drought will induce the development of lateral roots thereby increasing deeper water absorption (Hazman and Kabil, 2022).

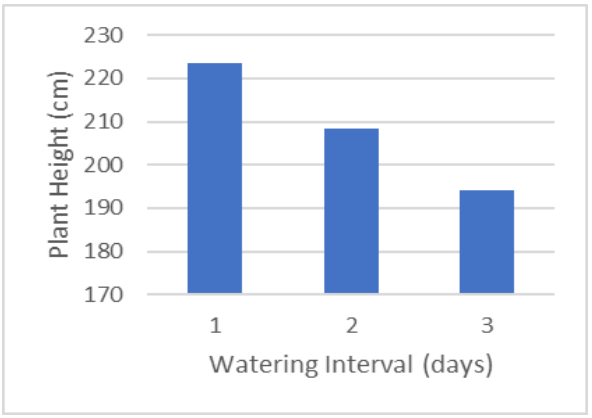

Figure 2. Relationship between watering interval and plant height

3.2 Plants' Growth

Based on the results of data analysis on plant height parameters, it shows that there are real differences between treatments. Watering once a day produces the highest plant height and is significantly different from watering every 2 days. Watering once every 2 days is not significantly different from watering once every 7 days, but watering once every day is significantly different from watering once every 7 days. Plant height significantly decreases with watering once every 7 days (Figure 1).

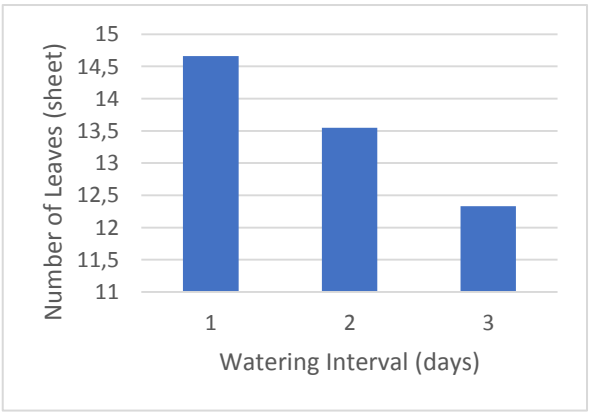

Figure 3. Relationship between watering interval and number of leaves

Watering treatment also affects the number of leaves of corn plants. The treatment of watering once a day gave the highest number of leaves, and was significantly different from watering every 2 days and watering every 7 days. The lowest number of leaves is shown when watering every 7 days (Figure 2).

In the vegetative growth phase, water needs must be met. If plants experience a lack of water in the vegetative phase, plant growth, especially plant height, can be hampered. According to Kim and Lee (2023) drought conditions can cause corn plants to become stunted and the leaves to curl. The decrease in the number of leaves at a watering interval of every 7 days will reduce the plant's ability to carry out photosynthesis, resulting in shorter corn plants. This is demonstrated by the results of the correlation analysis which shows that there is a very strong relationship (r=0.99879) between the number of leaves and the height of the corn plant.

3.3 Crop Yield

Based on the results of data analysis on the number of cobs, it shows that the parameter number of cobs, watering once a day is not significantly different from watering once every 2 days, while watering every 7 days is significantly different from watering once a day and watering once every 2 days.

Table 2. Effect of watering interval on ear number, ear length and ear diameter

Watering	Total Cobs (Seed)	Cobs Length (cm)	Cobs Diameter (cm)
1 day	1.22 ± 0.15 a	16.33 ± 0.04 a	4.46 ± 0.05 a
2 days	1.33 ± 0.22 a	15.67 ± 0.07 a	4.61 ± 0.11 a
7 days	0.56 ± 0.10 b	16.44 ± 0.21a	4.47 ± 0.02 a

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different based on the DMRT test at the 5% level

The highest number of cobs was shown when watering every 2 days and the lowest number of cobs was shown when watering every 7 days. Ear length and ear diameter were not influenced by watering intervals (Table 2).

During drought conditions, plants attempt to reduce transpiration by reducing the number of leaves (Figure 2). A smaller number of leaves will reduce the photosynthesis process of the plant so that the number of cobs produced is also reduced. This opinion is in line with the results of research conducted by (Ilmawan et al., 2019). Apart from that, the number of leaves on corn plants also has a close correlation with the number of cobs, as proven by the results of the data correlation test which shows a strong relationship between the number of leaves and the number of cobs (r=0.80873). The number of leaves affects the number of cobs because the leaves function as a site for the photosynthesis process which contributes to the yield of corn plants. This is in accordance with the opinion of (Surtinah, 2018) which states that the greater the number of leaves, the greater the number of cobs on a corn plant.

Table 3. Effect of watering interval on cob weight

Watering	Weight of cob with husk (gr)	Weight of cob without husk (gr)	Weight per 100 seeds (gr)
1 day	196.66 ± 0.05 a	160.77 ± 0.05 a	25.55 ± 0.07 a
2 days	173.55 ± 0.12 a	141.33 ± 0.23 a	25.88 ± 0.15 a
7 days	160.77 ± 0.21 a	130.88 ± 0.11 a	26.55 ± 0.15 a

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different based on the DMRT test at the 5% level

Based on the results of analysis of variance, it showed that watering intervals did not affect the parameters of cob weight with husks, cob weight without husks, weight per 100 seeds (Table 4). This shows that watering every 7 days does not cause a decrease in production of the BISI 18 corn variety. The BISI 18 corn variety has the character of being able to adapt to various soil and climate conditions.

One indicator of drought-resistant corn varieties is that plant yields do not decrease when experiencing drought stress. Using drought-resistant corn varieties will increase production by 15% when experiencing drought (Simtowe et al., 2019). In this study, watering at 7-day intervals did not reduce the yield components of the BISI 18 corn variety in terms of cob weight with or without husks and 100 kernel weight (Table 3). The decrease in the number of ears when watering every 7 days was not followed by a decrease in ear length and ear diameter (Table 2). This happens because the volume of the plant's roots does not decrease until it is watered every 7 days, so it is possible that the plant's ability to absorb water and nutrients does not decrease. According to (Yuwariah et al., 2022) in general, the weight of the cobs without husks determines the yield with a determination coefficient of 95%, while the weight of the cobs without husks and the number of seeds per row in some hybrids determine the yield.

Watering every 7 days also did not reduce the ear diameter (Table 2), so the weight of 100 seeds also did not decrease. According to (Dato, Arsa and Kasim, 2023) cob diameter affects corn production because the larger the cob circle, the heavier the corn. The increase in seed weight is greatly influenced by the amount of photosynthate that is distributed to the cob. The greater the photosynthate distributed or translocated to the cobs, the greater the food reserves that are translocated to the seeds, thereby increasing the weight of the seeds. On the other hand, if the photosynthate translocated to the cobs decreases, the lower the amount of food reserves translocated to the seeds, resulting in a decrease in seed weight.

In corn plants, there are several agronomic, physiological, and yield components that show a significant positive correlation with yield. These components include plant height, cob height, stem diameter, leaf area, chlorophyll content, relative water content, stomata opening area, wet peeled cob weight, cob length, number of harvested ears, number of seed/row, and weight of 1,000 seeds. It has been observed that drought-resistant varieties exhibit better agronomic characteristics and yield components (Marzuki et al., 2018). According to a study by Syauqi and Amzeri (2023), under optimal conditions,

drought-resistant corn varieties can be watered at intervals of once every 10 days, starting from plants aged 0 DAP to plants aged 80 DAP, until the field reaches its capacity.

4. CONCLUSION

1. Watering intervals of every 7 days can increase rooting properties, root length and root volume.
2. Watering intervals of once a day and every 2 days increase plant height and number of leaves.
3. Watering intervals of once every 7 days caused a decrease in the number of cobs but did not cause a decrease in cob length, cob diameter, cob weight with husks, cob weight without husks, weight per 100 seeds.
4. Watering every 7 days is more efficient and is recommended for farmers to save water, energy and time.

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