RESPONSE OF CORN (*Zea mays* L.) PLANTS DUE TO COMBINATIONS OF VARIOUS DOSES OF N, P, K FERTILIZERS, AND POPULATIONS

Aep Wawan Irwan[1]*, Agus Wahyudin[1], Fiky Yulianto Wicaksono[1], Ariza Nur Fitrianza[2]
[1]Department of Agronomy, Faculty of Agriculture, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km. 21, Jatinangor, Sumedang 45363, West Java, Indonesia
[2]Agrotechnology Undergraduate Program, Faculty of Agriculture, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km. 21, Jatinangor, Sumedang 45363, West Java, Indonesia
*Correspondence: a.wawan.irwan@unpad.ac.id

ABSTRACT

One effort to increase production is the use of hybrid seeds, specifically the Pertiwi-3 variety. To optimize, it is combined with fertilization and planting population management. This research aims to achieve optimal growth and yield by combining the effects of N, P, and K fertilizers and seed population. The study was conducted from February to June 2025 at Ciparanje, Faculty of Agriculture, Padjadjaran University. Randomized Block Design was used with 10 treatments and 3 replications, including: 50% fertilizer dose (N, P, K) + 1 seed; 75% dose of N, P, K + 1 seed; 100% dose of N, P, K + 1 seed; 125% dose of N, P, K + 1 seed; 150% dose of N, P, K + 1 seed; 50% of the N, P, K dose + 2 seeds; 75% of the N, P, K dose + 2 seeds; 100% of the N, P, K dose + 2 seeds; 125% of the N, P, K dose + 2 seeds; and 150% of the N, P, K dose + 2 seeds. The materials used were Pertiwi-3 hybrid seeds, urea, SP-36, and KCl. The research results showed that a combination of N, P, and K fertilizers and planting density affected plant height, leaf area index, cob length, number of kernels per row, dried kernel weight per plot, and dried kernel weight per hectare. The combination of a 75% fertilizer dose and two plant populations yielded the best results (2.70 kg/plot and 12.87 t/hectare).

Keywords: Doses; Maize; Macro Nutrient; Seed Population

Submitted : 12 December 2025
Accepted : 10 February 2026
Published : 10 February 2026

Irwan, A. W., Wahyudin, A., Wicaksono, F. Y., Fitrianza, A. N. (2025). Response of corn (*Zea mays* L.) plants due to combinations of various doses of N, P, K fertilizers, and populations. *Surjan, 2*(2), 58-68.

INTRODUCTION

Corn, as one of the important strategic food source crops in Indonesia, offers good nutrition and is economically priced, making it in high demand. Its kernels contain high levels of carbohydrates (up to 74%), protein, and fat, making it a popular alternative to rice as a food crop (Haslina et al., 2022). In addition, corn is also useful as animal feed, for handicrafts, and as an industrial raw material, increasing the demand for corn production.

Indonesia is one of the countries well-suited to corn cultivation, offering opportunities for corn production. However, the annual increase in corn production and productivity in Indonesia is still relatively low. According to BPS (2024), corn production in 2020 was 12.9 million tons/year and gradually increased to 16.5 million tons/year in 2022. In 2023, corn production declined again to 14.7 million tons.

Corn consumption in 2023 is expected to reach 16.31 million tons. In 2024, corn demand will reach 15.28 million tons, divided into feed industry raw materials, livestock raw materials, household consumption, and food industry raw materials (BPS, 2024). The high demand for corn indicates the need for technological improvements to optimize growth, thereby affecting corn production.

To increase corn growth, the use of superior varieties is one of the important factors that underpin efforts to optimize plant growth. One such effort is the use of superior hybrid seeds, such as the Pertiwi-3 hybrid corn variety in Indonesia. In terms of yield and productivity, the Pertiwi-3 hybrid corn variety is reported to offer advantages, with an average yield of up to 9.64 t/ha and a potential yield of up to 13.74 t/ha (Wicaksono & Maolana, 2018). Meanwhile, composite corn has a yield potential of 5-8 t/ha (Dewi et al., 2022).

Pertiwi-3 hybrid corn seeds are known to have several advantages, including a harvest age of around 10 MST until physiological maturity, a plant height of up to 196 cm, large cobs, straight and dense rows of kernels, 16-18 rows of kernels, and resistance to leaf rust, leaf blight, and smut. Efforts to increase productivity with superior hybrid varieties must also be complemented by measures to optimize growth. Agricultural land issues in Indonesia, such as shrinking land area, necessitate increased production through intensification programs that increase crop production by increasing land inputs, including factors related to corn cultivation. Basically, the corn cultivation process requires attention to factors from upstream to downstream, including optimal fertilization and crop population management. These factors work synergistically to improve corn growth and yield.

Nitrogen (N), phosphorus (P), and potassium (K) are macronutrients that are needed by plants in large quantities to determine the success of plant physiological processes, especially during the vegetative to generative phases. Nitrogen plays a role in the formation of amino acids that go on to form proteins, nucleic acids, and chlorophyll (Barker & Pilbeam, 2021). These substances or molecules play a direct role in plant physiological processes, such as photosynthesis. Phosphorus is an important nutrient for plants, serving as a key component of energy-transfer compounds and of the plant DNA and RNA systems. This ability makes P an essential element in the formation of plant tissues, such as roots and stems, and in stimulating flower growth (Lambers et al., 2008).

Element K plays a role in many biochemical and biophysical processes, including ATP synthesis, enzyme activity, carbon dioxide absorption, and the transport of photosynthetic products from leaves to reproductive organs (Nurhayati, 2021). These three elements are crucial nutrients required during the corn plant's growth period. Deficiencies in N, P, and K are common limiting factors encountered by farmers. Fertilization is an important way for corn plants to obtain the nutrients they need. Fertilizer application must be based on an appropriate, balanced dosage to avoid adverse effects on corn plant growth and yield, especially under varying seed numbers and densities (Simanjuntak et al., 2021). Based on the above description, it is important to conduct research on the effects of varying doses of N, P, and K fertilizers on corn plants under varying seed numbers.

Low corn production and productivity in Indonesia can also be influenced by suboptimal corn growth factors. Plant growth factors are broadly divided into biotic factors, which include microorganisms, pests, and diseases, and abiotic factors, which include soil, water, light, and climate. These factors need to work in harmony and balance for optimal plant growth. If one of these factors is disrupted and cannot function optimally, it will affect corn plant growth and yield. Therefore, in order to optimize corn plant growth and yield, efforts to increase crop production are needed.

One intensification program that can increase corn production is crop population engineering. Crop population engineering can be used to adjust to available growing space and the availability of water, light, and soil nutrients

(Wahyudin et al., 2015). Population density needs to be engineered to achieve optimal environmental carrying capacity, as each plant type requires a different density to maximize crop yields. In a study conducted by Made (2010), the average stem diameter in the treatment with one seedling per clump was larger and significantly different from those in the treatments with two and three seedlings per clump. This was inversely proportional to the plant height parameter, with the highest average plant height being in the three-clump treatment.

This is thought to occur because a high plant population increases competition within a clump, causing plants to grow taller to obtain light. In terms of yield, the average length and circumference of the largest cobs were greater in the treatment with 1 plant/clump than in the treatments with 2 plants/clump and 3 plants/clump, but the average weight of the largest cobs per clump was greater in the treatment with 2 plants/clump. This may be because higher plant population density increases the number of plants per unit area, thereby boosting corn production (Bolly, 2018).

The application of 180 g/plot (300 kg/ha) of NPK fertilizer had a greater effect on the growth and production of hybrid corn with a planting distance of 70 cm x 25 cm, yielding 5.046 t/ha (Djuniarty et al., 2023). Research by Suwardi and Herawati (2021) shows that an increase in population leads to higher production of hybrid corn varieties, except for Pioneer 21. The population of 71,428 crop/hectare was increased to 95,238 crop/hectare, with the highest increase in production occurring in the Bisi 2 variety (25.51%), the Bima 4 variety (25.38%), and the Bima 19 variety (25.94%).

The more plants per clump, the smaller the cobs produced, so adjustments to soil fertility are needed to achieve optimal cob size (Aprilyanto, 2016). In this case, corn plants need nutrients for growth, especially N, P, and K, during both the vegetative and generative phases. Optimizing nutrient levels in plants is achieved through fertilization. However, fertilizer use needs to be effective and efficient. The addition of efficient inorganic fertilizers can yield good results in corn cultivation. According to Aprilyanto's (2016) research, planting crops at a density of up to 80,000 per hectare and applying moderate doses of N, P, and K fertilizers (300 kg urea + 200 kg SP36 + 150 kg SP36) produced the highest cob weight per hectare.

The element N in plants functions in the formation of chlorophyll, which is important for photosynthesis, and in the formation of proteins. The element P found in soil can originate from organic materials, such as manure or chemical fertilizers. The element P plays a very important role in the processes of respiration, cell division, and tissue formation in plants, including corn. In plants, the element K is involved in many biochemical and biophysical processes. The element K is involved in ATP synthesis, enzyme activity, carbon dioxide absorption, and the transport of photosynthetic products from the leaves to the reproductive organs (Nurhayati, 2021).

Inorganic fertilization is one method used in crop cultivation to supplement limited nutrients. Organic fertilizers are made from materials that contain high levels of nutrients, such as urea (45% N), SP36 (36% P_2O_5), and KCl (63% K_2O). The results of research conducted by Sitorus et al. (2015) indicate that applying compound NPK fertilizer (15-15-15) at 300 kg/ha yields the highest corn yield of 6.93 t/ha. The effect of fertilizer dose treatments N (Urea = 45% N), P (SP36 = 36% P_2O_5), and K (KCl = 63% K_2O) at 75% of the recommended dose had the best effect on corn yield components, namely cob length and grain weight per plant (Wicaksono & Maolana, 2018). According to Muhadzir (1987), the formation of corn cobs is influenced by nutrient factors. If corn plants experience a deficiency in these nutrients, cob formation will be incomplete, so fertilization is an effective way to help produce good-quality corn cobs.

MATERIALS AND METHODS

The research was conducted from March 2025 to June 2025 at the Ciparanje Experimental Station, Faculty of Agriculture, Padjadjaran University, Sumedang Regency, West Java. The research location has an altitude of approximately ±750 meters above sea level, with D3 rainfall according to Oldeman's classification (1957).

The materials used in this study were Pertiwi-3 hybrid corn seeds, urea fertilizer (45% N), SP36 (36% P_2O_5), KCl (63% K_2O), and Curacron pesticide containing the active ingredient Profenofos at 500g/L. The tools used in this study were agricultural tools, calipers, rulers, analytical scales, electric ovens for drying plants, meters for measuring planting distance, plant height, and leaf area, labels, and writing instruments.

A randomized block design (RBD) was used in this study, with 10 treatments and 3 replicates per treatment, yielding 30 experimental plots. Each experimental plot measured 2 m x 1.2 m, with 30 cm between plots and 1 m between replicates. Each treatment plot consisted of 15 plants with a planting distance of 75 cm x 30 cm. 15% of the plants per plot (3 plants) were randomly selected, excluding those on the edge of the plot.

The treatment design used is as follows: A = 50% dose of N, P, K fertilizer + population of 1 seed, B = 75% dose of N, P, K fertilizer + population of 1 seed; C = 100% dose of N, P, K fertilizer + 1 seed population; D = 125% dose of N, P, K fertilizer + 1 seed population; E = 150% dose of N, P, K fertilizer + 1 seed population; F = 50% N, P, K fertilizer dose + 2 seed population; G = 75% N, P, K fertilizer dose + 2 seed population; H = 100% N, P, K fertilizer dose + 2 seed population; I = 125% of the N, P, K fertilizer dose + 2 seed population; and J = 150% of the N, P, K fertilizer dose + 2 seed population.

Observations were made on the growing environment and pest organisms as supporting observations, while the main observations consisted of plant height, leaf area index, cob length, cob diameter, number of rows of seeds per cob, number of seeds per row, weight of 100 seeds, seed weight per planting, seed weight per plot, and yield per hectare.

RESULTS AND DISCUSSION

Growing Environment and Pests

The pest that attacks plants is the grasshopper (*Valanga nigricornis*). Grasshoppers attack plants, especially when young, causing leaves to become torn and perforated. However, field trials show that the level of grasshopper attack does not cause significant damage, around 5-10%. Control by spraying Curacron 500 EC at a concentration of 2 mL/L water (when an attack occurs), namely at 5 weeks after planting and 8 weeks after planting (critical phase).

The weeds that predominated on the experimental land were nutgrass (*Cyperus rotundus*), sensitive plant (*Mimosa pudica*), and Bermuda grass (*Cynodon dactylon*). Weed control was carried out mechanically. Based on the soil analysis results, the soil where the experiment was conducted is classified as an inceptisol. The soil has a dusty clay texture with a composition of 16% sand, 40% dust, and 44% clay. The measured soil pH of 5.6 (acidic) is still suitable for planting hybrid corn (Sumarno, 2011). Based on a comparison of the organic C (2.94%) and total N (0.25%) content, the soil has a C/N ratio of 13 (moderate), indicating that the level of decomposition of organic matter in the soil is moderate. The experimental soil has an available P_2O_5 content (Bray) of 9.2 ppm (low), total P_2O_5 (HCl) of 22.4 mg/100g (medium), and K_2O (HCl) of 20.1 mg/100 g (moderate), cation exchange capacity 18.2 me/100 g (moderate), and base saturation 47% (low). Rainfall data during the study period showed that the average rainfall (February to June 2025) in June was 224.5 mm.

Plant Height

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on plant height are shown in Table 1. The statistical results show that the combination of seed population and N, P, K fertilizer doses had no significant effect on plant height at 4 weeks after planting (WAP) and 6 WAP, but at 8 WAP, the combination of seed population and N, P, K fertilizer doses showed a significant effect (Table 1).

The application of N, P, and K fertilizers at 75% of the recommended dose, with 2 seeds per planting hole (treatment G), tended to yield the highest average plant height at 4, 6, and 8 weeks after planting (WAP). When applying 75% of the recommended doses of N, P, and K fertilizers, both planting 1 and 2 seeds produced average heights that were not significantly different. Planting 2 seeds combined with 75% of the recommended dose of N, P, and K fertilizer tended to produce the highest average plant height at 4, 6, and 8 WAP. This is thought to be because the application of sufficient nutrients, mainly N, can stimulate plant metabolic activity.

According to Made (2010), sufficient availability of nitrogen nutrients allows plants to form vegetative parts appropriately, as meristematic tissue requires nitrogen for cell division and the formation of new cell walls. Plant height is an important component of plant growth and is greatly influenced by factors such as fertilizer and population engineering. Population control directly affects plant acceptance of growth factors, including sunlight. In addition, according to Muhsanati et al. (2022), plant population is related to plant density, which, in turn, affects plant transpiration. The test results showed that planting 2 seeds produced taller plants. This is thought to be due to competition between plants for sunlight, which is one of the factors affecting plant height.

This is in line with the statement by Kantikowati et al. (2022) that narrow planting distances cause plants to grow close together, shading each other and reducing the amount of light they receive. In this case, the plants will activate the auxin hormone in plant tissue, causing cell elongation and stimulating and accelerating vegetative growth. Crowded plants also exhibit phototropism, in which they grow toward light sources, elongating (Kantikowati et al., 2022).

Table 1. Effect of the Combined Treatment of N, P, K Fertilizer Dosage and Seed Population Size on the Height of Pertiwi 3 Hybrid Corn Plants

Treatments	Plant Height (cm)		
	4 WAP	6 WAP	8 WAP
A (50% dose N, P, K recommend + 1 seed)	22.85 a	103.58 a	160.27 a
B (75% dose N, P, K recommend + 1 seed)	22.52 a	117.93 a	172.20 b
C (100% dose N, P, K recommend + 1 seed)	22.08 a	106.60 a	152.63 a
D (125% dose N, P, K recommend + 1 seed)	21.36 a	93.33 a	159.10 a
E (150% dose N, P, K recommend + 1 seed)	24.47 a	112.08 a	167.53 b
F (50% dose N, P, K recommend + 2 seeds)	22.52 a	111.53 a	172.03 b
G (75% dose N, P, K recommend + 2 seeds)	29.14 a	140.33 a	183.43 b
H (100% dose N, P, K recommend + 2 seeds)	26.79 a	125.03 a	182.27 b
I (125% dose N, P, K recommend + 2 seeds)	24.86 a	107.43 a	168.93 b
J (150% dose N, P, K recommend + 2 seeds)	24.79 a	119.23 a	169.37 b
Control (Without NPK + 1 seed)	22.01 a	101.94 a	159.00 a

Note: Mean value in each column marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

Leaf Area Index

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on Leaf Area Index (LAI) are shown in Table 2. Statistical data show that the combination of seed population and N, P, and K fertilizer doses has no significant effect on leaf area index.

In Table 2, the leaf area index in the treatment with 1 seed population (A, B, C, D, and E) tended to be lower, although it was not significantly different from that in treatments (F, G, H, I, and J). Treatment H (100% recommended dose of N, P, K + 2 seeds) produced a higher ILD value. This is because using more seeds resulted in a higher number of leaves per unit area, thereby increasing the leaf area index. This means that the more seeds planted and the denser the plants, the higher the leaf area index value. Leaf area index is influenced by leaf density, which in turn depends on plant population and planting distance. This is in line with research by Khakim et al. (2019), which shows that the highest leaf area index is found at the most dense planting distance. The denser the planting, the less sunlight reaches the leaves, thereby increasing the leaf area index.

Table 2. Effect of the Combined Treatment of N, P, K Fertilizer Dosage and Seed Population Size to the Leaf Area Index of Pertiwi 3 Hybrid Corn Plants

Treatments	LAI
A (50% dose N, P, K recommend + 1 seed)	22.85 a
B (75% dose N, P, K recommend + 1 seed)	22.52 a
C (100% dose N, P, K recommend + 1 seed)	22.08 a
D (125% dose N, P, K recommend + 1 seed)	21.36 a
E (150% dose N, P, K recommend + 1 seed)	24.47 a
F (50% dose N, P, K recommend + 2 seeds)	22.52 a
G (75% dose N, P, K recommend + 2 seeds)	29.14 a
H (100% dose N, P, K recommend + 2 seeds)	26.79 a
I (125% dose N, P, K recommend + 2 seeds)	24.86 a
J (150% dose N, P, K recommend + 2 seeds)	24.79 a
Control (Without NPK + 1 seed)	22.01 a

Note: Mean value marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

The Leaf Area Index (LAI) aims to determine the extent of light reception distribution in a plant. Leaves are vegetative organs in which various physiological processes take place, such as photosynthesis. An optimum number of leaves can provide a more even distribution of light reception (Zakariyya, 2016). In addition, a larger leaf surface area indicates that plants can absorb more sunlight, thereby optimizing photosynthesis. According to Wulansari and Widaryanto et al. (2017), hybrid varieties have an optimal leaf area index of 3.3-4.0.

If the leaf area index is too high, the lower leaves are shaded, preventing them from receiving optimal sunlight. In the research by Wulansari & Widaryanto (2017), the use of 150 kg/hectare, 50 kg/hectare SP36, and 25 kg/hectare KCl resulted in higher leaf area index than lower fertilizer treatments. Fertilizer is one of the factors that support photosynthesis, supplying the nutrients plants need. The leaf area index can provide an overview of the optimization of plant photosynthesis, thereby also illustrating the capacity of plants to produce photosynthates (Wulansari & Widaryanto, 2017).

Cob Length and Cob Diameter

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on cob length and cob diameter are shown in Table 3. Statistical data show that the combination of seed population and N, P, and K fertilizer doses significantly affects cob length but not cob diameter.

All treatments with 2 seeds did not differ significantly from each other, but did differ significantly from the control and treatments A, B, and C, which had 1 seed. Based on Table 7, treatment B (75% of the recommended N, P, K dose + 1 seed) tended to produce longer cobs. For cob diameter, the statistical analysis showed that the combination of population and N, P, and K fertilizers did not differ significantly.

According to Muhadzir (1987), as cited in Wahyudin (2018), the cob serves as a storage organ for corn plants. The element that plays a major role in cob formation is phosphorus (P). A deficiency of P will result in small cobs, irregular rows of seeds, and less content. N, P, and K fertilizers are important elements for growth. According to Made (2010), the availability of sufficient nutrients causes a balance between the leaves and roots, resulting in more optimal vegetative growth. Such conditions will later prompt the plant to enter the generative growth phase. The balance between vegetative and generative growth can improve the reproductive organs as a whole. This is thought to be due to the use of sufficient N, P, and K fertilizers and the small number of seeds producing optimal cobs.

Table 3. Effect of the Combined Treatment of N, P, K Fertilizer Dosage and Seed Population Size on Cob Length and Cob Diameter in Pertiwi Hybrid Corn Plants

Treatment	Cob Length (cm)	Cob Diameter (cm)
A (50% dose N, P, K recommend + 1 seed)	15.46 b	4.49 a
B (75% dose N, P, K recommend + 1 seed)	16.32 b	4.69 a
C (100% dose N, P, K recommend + 1 seed)	15.85 b	4.43 a
D (125% dose N, P, K recommend + 1 seed)	14.83 a	4.57 a
E (150% dose N, P, K recommend + 1 seed)	14.39 a	4.58 a
F (50% dose N, P, K recommend + 2 seeds)	14.52 a	4.29 a
G (75% dose N, P, K recommend + 2 seeds)	14.85 a	4.43 a
H (100% dose N, P, K recommend + 2 seeds)	14.95 a	4.82 a
I (125% dose N, P, K recommend + 2 seeds)	14.30 a	4.24 a
J (150% dose N, P, K recommend + 2 seeds)	14.86 a	4.75 a
Control (Without NPK + 1 seed)	16.04 b	4.81 a

Note: Mean value in each column marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

The average length of the cobs in treatments F, G, H, I, and J, with the use of 2 seeds per hole, showed significant differences, but were significantly different from treatments A, B, and C, which used 1 seed per hole. This is thought to be because in the 2 seeds per hole treatment, the plants will overlap and compete with each other. According to Made (2010), the population density within clumps leads to competition because roots overlap, thereby affecting water and nutrient absorption around the plants. This aligns with Simanjuntak's (2021) research, which found that the number of seeds planted significantly affects cob length, as competition between plants inhibits growth. In addition, a lack of nutrients due to competition can lead to an uneven distribution of cob sizes.

Number of Rows per Cob and Number of Seeds per Row

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on the number of rows per cob and the number of seeds per row are shown in Table 4. Statistical data show that the combination of seed population and N, P, and K fertilizer doses has no significant effect on the number of rows per cob, but has a significant effect on the number of seeds per row.

Table 4. Effect of the Combined Treatment of N, P, K Fertilizer Dosage and Seed Population Number on the Number of Rows per Ear of Pertiwi 3 Hybrid Corn Plants

Treatment	Number of rows per cob	number of seeds per row
A (50% dose N, P, K recommend + 1 seed)	15.02 a	25.19 b
B (75% dose N, P, K recommend + 1 seed)	15.01 a	28.01 c
C (100% dose N, P, K recommend + 1 seed)	14.68 a	27.57 c
D (125% dose N, P, K recommend + 1 seed)	15.10 a	25.00 b
E (150% dose N, P, K recommend + 1 seed)	14.17 a	25.38 b
F (50% dose N, P, K recommend + 2 seeds)	15.00 a	22.57 a
G (75% dose N, P, K recommend + 2 seeds)	15.49 a	26.37 c
H (100% dose N, P, K recommend + 2 seeds)	15.69 a	25.52 b
I (125% dose N, P, K recommend + 2 seeds)	14.20 a	25.52 b
J (150% dose N, P, K recommend + 2 seeds)	15.40 a	25.71 b
Control (Without NPK + 1 seed)	14.07 a	24.23 b

Note: Mean value in each column marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

The combination of seed population and N, P, and K fertilizer doses significantly affected the number of seeds per ear row. Treatment B (75% of the recommended N, P, K doses + 1 seed) tended to produce the highest average number of seeds per row. This is in line with the research by Pusparini et al. (2018) that corn productivity can be determined by cob length, number of rows, and corn seed weight, with longer cobs having the potential to produce higher yields, as longer cobs indicate seed density and are closely related to the number of seeds per cob. The longer the cob, the more seeds there are in each row. This is thought to be due to meeting N, P, and K requirements and planting 1 seed per hole, which minimizes plant competition and results in larger cobs and more seeds.

N, P, and K fertilizers are important elements for growth. According to Made (2010), the availability of sufficient nutrients can trigger more optimal vegetative growth. This will affect the plant's ability to continue into the generative growth phase. The balance between vegetative and generative growth can improve the reproductive organs as a whole. Optimal and appropriate seed planting will reduce competition between plants, so that the development of cobs between plants does not overlap. According to Simanjuntak's (2021) research, a lack of nutrients due to competition results in an uneven distribution of cob sizes.

The average number of seeds per row of the smallest plants was found in treatment F, which used 50% of the recommended amount of fertilizer and combined with 2 seeds per planting hole. This is also thought to be due to the N, P, and K fertilizer requirements not being fully met, resulting in suboptimal plant cobs. One of the main elements in cob formation is phosphorus (P). According to Barker & Pilbeam (2021), phosphorus is useful for plants to assist in the assimilation process and to accelerate the ripening of seeds and fruits, which is continuous with the development of cobs in corn plants.

This P deficiency inhibits cob formation, resulting in suboptimal cob growth and small cobs. Cobs with small lengths and diameters affect the number of kernels per row and the total number of kernels in the cob. A dense seed count of 2 seeds also affects corn cob formation. In line with Simanjuntak's (2021) research, which found that the number of seeds planted significantly affects cob length, as competition between plants stunts growth, resulting in a suboptimal number of seeds per cob.

Weight of 100 Seeds (g) and Weight of Dry Seeds per Plant

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on the weight of 100 seeds and the weight of shelled seeds per plant are shown in Table 5. Statistical data show that the combination of seed population and N, P, and K fertilizer doses has no significant effect on the weight of 100 seeds or the weight of dry seeds per plant.

Table 5. Effect of the combination treatment of N, P, K fertilizer doses and seed population density to the 100-seed weight and dry seed weight per plant on Pertiwi 3 hybrid corn plants

Treatment	100-seed weight (g)	dry seed weight per plant (g)
A (50% dose N, P, K recommend + 1 seed)	24.56 a	150 a
B (75% dose N, P, K recommend + 1 seed)	22.57 a	140 a
C (100% dose N, P, K recommend + 1 seed)	23.93 a	150 a
D (125% dose N, P, K recommend + 1 seed)	23.52 a	130 a
E (150% dose N, P, K recommend + 1 seed)	24.29 a	120 a
F (50% dose N, P, K recommend + 2 seeds)	24.98 a	140 a
G (75% dose N, P, K recommend + 2 seeds)	26.65 a	170 a
H (100% dose N, P, K recommend + 2 seeds)	27.79 a	150 a
I (125% dose N, P, K recommend + 2 seeds)	23.59 a	110 a
J (150% dose N, P, K recommend + 2 seeds)	26.81 a	140 a
Control (Without NPK + 1 seed)	25.02 a	140 a

Note: Mean value in each column marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

According to Muhsanati et al. (2022), the weight of 100 seeds and the weight per plant can describe seed size and density, indicators of corn seed quality. The higher the weight of 100 seeds and the weight per plant, the better the seed quality. The formation of cobs and seed filling is determined by photosynthates translocated to develop the plant's reproductive organs. Thus, an increase in seed weight per plant is related to the amount of photosynthate translocation into the seeds, so that if the nutrient status is sufficient, the better the root status of the plant, which functions to absorb nutrients from the soil into the seeds.

Based on research by Wicaksono & Maolana (2018), treatment levels of 100% N, P, and K, and 75% N, P, and K produced 100 seed weight and 100 dry shell weight per plant that were not significantly different. This can be attributed to the nutrients provided, which were appropriate for corn plants, resulting in stable seed growth. According to Aisyah (2008), phosphorus is the second most essential element after nitrogen and acts as a carbohydrate breaker, providing energy storage for all parts of the plant. Phosphorus is also known to play a role in cell division, passing on traits through DNA, accelerating maturity, and in the formation of fruits and seeds, especially cobs in corn plants.

Weight of Shelled Seeds per Plot and Weight of Shelled Seeds per Hectare

Observation data and statistical analysis results for the combination of seed population and N, P, and K fertilizer doses on the weight of dry seeds per plot and per hectare are shown in Table 6. The statistical results show that the combination of seed population and N, P, and K fertilizer doses has a significant effect on dry seed weight per plot and per hectare.

The analysis results show that planting two seeds per hole can produce higher dry grain weight per plot and per hectare, and the difference is significantly greater than planting one seed per hole. Treatment G (75% of the recommended dose of N, P, K + 2 seeds) tended to produce higher seed weight. This is thought to be because nutrient requirements were met, and the higher number of seeds per planting hole resulted in more plants, which in turn produced more cobs, resulting in a higher number of kernels compared to plants that were only planted with 1 seed. This is in line with the research by Regyta et al. (2023), which found that the highest average weight per plot was in the treatment with two seeds per hole. According to Regyta et al. (2023), cob development in plants is associated with size, cell number, and internode development, all of which require substantial photosynthate synthesis. The more photosynthates there are, the more cobs and seeds are formed.

CONCLUSION

Based on the description of the research results and analysis above, it can be concluded that there is an effect of the combination of N, P, K fertilizers and plant population on growth, namely plant height, Leaf Area Index, cob length, number of seeds per row, dry seed weight per plot, and dry seed weight per hectare. The combination of fertilizer treatments with N, P, and K at 75% of the recommended dose and 2 plant populations tended to yield the best results, with a dry seed weight of 2.70 kg/plot and 12.87 tons/hectare.

Table 6. Effect of the Combined Treatment of N, P, K Fertilizer Dosage and Seed Population to Seed Weight per Plot and Seed Weight per Hectare

Treatment	Seed Weight per Plot (kg)	Seed Weight per Hectare (t)
A (50% dose N, P, K recommend + 1 seed)	1.52 a	7.22 a
B (75% dose N, P, K recommend + 1 seed)	1.78 a	8.49 a
C (100% dose N, P, K recommend + 1 seed)	1.58 a	7.54 a
D (125% dose N, P, K recommend + 1 seed)	1.13 a	5.40 a
E (150% dose N, P, K recommend + 1 seed)	1.57 a	7.46 a
F (50% dose N, P, K recommend + 2 seeds)	2.15 b	10.24 b
G (75% dose N, P, K recommend + 2 seeds)	2.70 b	12.87 b
H (100% dose N, P, K recommend + 2 seeds)	2.42 b	11.51 b
I (125% dose N, P, K recommend + 2 seeds)	2.37 b	11.27 b
J (150% dose N, P, K recommend + 2 seeds)	26.81 a	140 a
Control (Without NPK + 1 seed)	25.02 a	140 a

Note: Mean value in each column marked with the same letter are not significantly different according to the Scott-Knott test at the 5% level.

Suggestions for further research include conducting studies across different seasons or climate types to observe differences in corn plant responses. Research should also be conducted in locations with varying elevations, including lowlands with varying levels of fertility and different irrigation systems.

REFERENCES

Ansoruddin, A., Wahyudin Purba, D., Lestari Butar-Butar, W., Azhari, M. N., Rafitra, M. R., & Hidayat Tarigan, R. (2022). Efek Pertumbuhan Tanaman Jagung (*Zea mays*) Terhadap Aspek Agronomi Di Bawah Naungan Kelapa Sawit. *Jurnal Agrium*, *19*(3), 384. https://doi.org/10.29103/agrium.v19i4.9743

Barker, A. V., & Pilbeam, D. J. (2021). *Handbook of Plant Nutrition*. CRC Press. https://www.routledge.com/Handbook-of-Plant-Nutrition/Barker-Pilbeam/p/book/9781032098630

Bolly, Y. Y. (2018). Pengaruh Jarak Tanam dan Jumlah Benih Perlubang Tanam Terhadap Pertumbuhan dan Hasil Tanaman Jagung Manis (*Zea mays* Sacaratha L.) Bonanza F1 Di Desa Wairkoja, Kecamatan Kewapante, Kabupaten Sikka. *Journal of Dryland Agriculture*, *11*(2), 164–178.

BPS. (2024). Luas Panen, Produksi, dan Produktivitas Jagung Menurut Provinsi - Tabel Statistik - Badan Pusat Statistik Indonesia. https://www.bps.go.id/id/statistics-table/2/MjIwNCMy/luas-panen--produksi--dan-produktivitas-jagung-menurut-provinsi.html

BPTP, J. B. (2016). Petunjuk Teknis Pengelolaan Tanaman Terpadu (PTT) Jagung.

Dewi, A. S., Setiawan, D. H., & Novitaningrum, R. (2022). Potensi dan Pengembangan Jagung Hibrida di Indonesia. *Journal Science Innovation and Technology (SINTECH)*, *3*(1), 1–6. https://www.researchgate.net/publication/375428454_POTENSI_DAN_PENGEMBANGAN_JAGUNG_HIBRIDA_DI_INDONESIA/fulltext/654a31443fa26f66f4e257d2/POTENSI-DAN-PENGEMBANGAN-JAGUNG-HIBRIDA-DI-INDONESIA.pdf

Djuniarty, Djuniarty, Virawaty Virawaty, and Rahman Syafar. "Pertumbuhan dan Produksi Jagung Hibrida pada berbagai jarak tanam dan dosis pupuk NPK."*Journal Agroecotech Indonesia (JAI)*2.02 (2023): 101-111.

Efendi, R., & Suwardi. (2010). Respon Tanaman Jagung Hibrida terhadap Tingkat Takaran Pemberian Nitrogen dan Kepadatan Populasi. *Prosiding Pekan Serealia Nasional*, 261–268.

Fahmi, A., Utami, S. H. N., & Radjagukguk, B. (2010). Pengaruh Interaksi Hara Nitrogen dan Fosfor terhadap Pertumbuhan Tanaman

Jagung (*Zea mays* L) Padatanahregosol dan Latosol. *Berita Biologi*, *10*(3), 297–304.

Fahmi Aliansyah, A., Hariningsih Pratiwi, S., & Sulistyawati, D. (2022). Respon Pertumbuhan Dan Hasil Tanaman Jagung Manis (*Zea mays* L. Sacharata Sturt.) Terhadap Pemberian Pupuk Nitrogen Dan Pemangkasan Daun Bagian Bawah. *Jurnal Agroteknologi Merdeka Pasuruan*, *6*(2), 32–39. https://doi.org/10.51213/JAMP.V6I2.77

Fiqriansyah W, , M., Putri, ,, Syalsa Aulia, Syam, R., & Rahmadani, A. S. (2021). *Teknologi Budidaya Tanaman Jagung (Zea mays) dan Sorgum (Sorghum bicolor* (L.) Moench). 1–58.

Gomez, A. A., & Gomez, K. A. (1984). Statistical procedures for agricultural research: Second Edition. *A Wiley-Interscience Publication*, *6*, 1–690. https://www.wiley.com/en-us/Statistical+Procedures+for+Agricultural+Research%2C+2nd+Edition-p-9780471870920

Haslina, Larasati, D., & Iswoyo. (2022). *Buku Ajar Rambut Jagung Sebagai Pangan Fungsional*. Universitas Semarang Press. https://repository.usm.ac.id/detail-buku-179.html

Havlin, J. L., Tisdale, S., Nelson, & Beaton, J. (2013). *Soil Fertility and Fertilizers*. Pearson Education. https://www.researchgate.net/publication/366175716_Soil_Fertility_and_Fertilizers_by_John_L_Havlin_z-liborg

Jaya, I. K. D. (2004). Pertumbuhan dan Hasil Jagung Semi yang Ditanam dengan Kerapatan dan Orientasi Berbeda. *Agroteksos*, *13*(4), 196–200.

Kantikowati, E., Karya, & Khotimah, I. H. (2022). Pertumbuhan dan Hasil Jagung Manis (*Zea mays* Saccharata Sturt) Varietas Paragon Akibat Perlakuan Jarak Tanam dan Jumlah Benih.pdf. *Jurnal Ilmiah Pertanian AgroTatanen*, *4*(2), 1–10.

Khakim, M., Pratiwi,ri H., & Basuki, N. (2019). Analisis Pertumbuhan dan Hasil Tanaman Padi (*Oryza sativa* L.) pada Pola Tanam Sri (System Of Rice Intensification) dengan Perbedaan Umur Bibit dan Jarak Tanam. *Jurnal Agroteknologi Merdeka Pasuruan*, *3*(1), 24–31.

Kumar, B., Karjagi, C. G., Jat, S. L., & Parihar, C. M. (2015). Essential Elements: Macronutrients. In *Handbook of Plant Nutrition, Second Edition*. https://doi.org/10.1201/b18458-4

Lambers, H., Chapin, F. S., & Pons, T. L. (2008). Plant Water Relations. In *Plant Physiological Ecology*. https://doi.org/10.1007/978-0-387-78341-3_5

Made, U., & Pertanian, J. B. (2010). Respons Berbagai Populasi Tanaman Jagung Manis (*Zea mays* Saccharata Sturt.) Terhadap Pemberian Pupuk Urea. *J. Agroland*, *17*(2), 138–143.

McKenzie, R. H. (2001). *Potassium fertilizer application in crop production - Potassium fertilizer application in crop production (Revised January 2013) - Open Government*. Research and Innovation Division, Alberta Agriculture and Rural Development. https://open.alberta.ca/dataset/6060438/resource/7c314fad-3df0-4f28-aeff-0a6d7d72910b

Muhsanati, M., Dwipa, I., & Hasibuan, M. R. (2022). Respon Tanaman Jagung *(Zea mays*) pada Beberapa Jarak Tanam dan Komposisi Pemupukan. *Jagur Jurnal Agroteknologi*, *4*(1), 25–35. https://doi.org/10.25077/jagur.4.1.25-35.2022

Muis, A., Suriani, & Septian Hary Kalqutny. (2021). *Penyakit Bulai Pada Tanaman Jagung dan Upaya Pengendaliannya* (Nomor November 2018). deepublish.

Nurhayati, D. R. (2021). Pengantar Nutrisi Tanaman. In *UNISRI Press*. https://press.unisri.ac.id/wp-content/uploads/2021/02/A5_PENGANTAR-NUTRISI-TANAMAN-DEWI-2020.pdf

Nurmavina, T. W., Soedarto, T., & Amir, I. T. (2021). *Kabupaten Sidoarjo Level Of Farmer ' S Satisfaction With The Use Of Hybrid Corn Seed In Singkalan Village , Balongbendo District , Sidoarjo Regency Tri Wahyu Nurmavina *, Teguh Soedarto* , Indra Tjahaja Amir Fakultas Pertanian Program Studi Agribisnis Univ. *Jurnal Ilmiah Mahasiswa AGROINFO GALUH*, *8*(3), 783–795.

Parwi, P. (2012). Pengaruh dosis pupuk fosfor (P) dan pupuk kalium (K) terhadap pertumbuhan dan hasil jagung manis (*Zea mays*). *Flora*, *8*(2), 21–41. https://doi.org/10.26905/FLORA.V8I2.8785

Pusparini, P. G., Yunus, A., & Harjoko, D. (2018). Dosis Pupuk NPK Terhadap Pertumbuhan dan Hasil Jagung Hibrida. *Agrosains: Jurnal Penelitian Agronomi*, *20*(2), 28.

https://doi.org/10.20961/agsjpa.v20i2.21958

Regyta, S., Ritonga, A. W., & Permatasari, O. S. I. (2023). Kajian Jumlah Benih Per Lubang Tanaman terhadap Pertumbuhan dan Produksi Tanaman Jagung Manis (*Zea mays* saccharata. Sturt). *Bul. Agrohorti.*, *11*(1), 103–105.

Riwandi, R., Merakati, H., & Hasanudin, H. (2014). *Teknik Budidaya Jagung Dengan Sistem Organik Di Lahan Marjinal*.

Setiyawan, D. E., Munandar, D. E., & Setiyono. (2017). Pengaruh Perbedaan Naungan Terhadap Pertumbuhan Dan Hasil Tiga Varietas Jagung Komposit. In *Efektifitas Penyuluhan Gizi pada Kelompok 1000 HPK dalam Meningkatkan Pengetahuan dan Sikap Kesadaran Gizi* (Vol. 3, Nomor 3).

Simanjuntak, P., Manalu, C. J. F., & Sitepu, A. (2021). Efektivitas Penggunaan Pupuk Npk Phonska Dan Jumlah Benih Per Lubang Tanam Terhadap Pertumbuhan Dan Produksi Tanaman Jagung Manis (*Zea mays* Saccharatta Sturt). *Majalah Ilmiah METHODA*, *11*(3), 201–206. https://doi.org/10.46880/methoda.vol11no3.pp201-206

Subekti, N. A., Syafruddin, Efendi, R., & Sunarti, S. (2008). Morfologi Tanaman dan Fase Pertumbuhan Jagung. *Balai Penelitian Tanaman Serealia, Maros*, 16–28.

Supriyanta, B., Wicaksono, D., & Suryotomo, A. P. (2020). *Teknik Budidaya Dan Pemuliaan Tanaman Jagung Manis*. LPPM UPN "Veteran" Yogyakarta.

Suwardi, Suwardi, and Herawati Herawati. 2021. Pengaruh varietas dan populasi tanaman terhadap peningkatan produtivitas jagung hibrida.*Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam*18.2 (2021): 124-137.

Uge, E., Yusnawan, E., & Baliadi, Y. (2021). Pengendalian Ramah Lingkungan Hama Ulat Grayak (*Spodoptera litura* F.) pada Tanaman Kedelai. *Buletin Palawija*, *19*(1), 64–80.

Wahyudin, A., Ruminta, R., & Bachtiar, D. C. (2015). Pengaruh jarak tanam berbeda pada berbagai dosis pupuk organik terhadap pertumbuhan dan hasil jagung hibrida P-12 di Jatinangor. *Kultivasi*, *14*(1). https://doi.org/10.24198/KULTIVASI.V14I1.12097

Wahyudin, A., Yuwariah, Y. Y., Wicaksono, F. Y., & Bajri, R. A. G. (2018). Respons jagung (*Zea mays* L.) akibat jarak tanam pada sistem tanam legowo (2:1) dan berbagai dosis pupuk nitrogen pada tanah inceptisol Jatinangor. *Kultivasi*, *16*(3), 507–513. https://doi.org/10.24198/kultivasi.v16i3.14390

Wahyurini, E., Supriyanta, B., & Antik, S. (2022). *Teknik Budidaya Dan Keragaman Genetik Jagung Manis*. Lembaga Penelitian dan Pengabdian Kepada Masyarakat UPN "Veteran" Yogyakarta.

Wicaksono, F., & Maolana, I. (2018). *Pengaruh dosis pupuk hayati dan pupuk N , P , K terhadap komponen hasil dan hasil jagung (Zea mays* L *.) di dataran medium Jatinangor*. *17*(2), 633–638.

Wijaya;, K. A. (2008). *Nutrisi Tanaman : Sebagai Penentu Kualitas Hasil dan Resistensi Alami Tanaman*. Prestasi Pustaka. //perpustakaan.thamrin.ac.id/index.php?p=show_detail&id=1612&keywords=

Wulansari, H. R., & Widaryanto, E. (2017). Respon Tanaman Jagung Manis (*Zea mays* saccharata Sturt L.) pada Berbagai Jenis Mulsa terhadap Tingkat Pemberian Air. *Jurnal Produksi Tanaman*, *5*(8), 1389–1398.

Zakariyya, F. (2016). Menimbang Indeks Luas Daun sebagai Variabel penting Pertumbuhan Tanaman Kakao. *Warta Pusat Penelitian Kopi dan Kakao Indonesia*, *28*(3), 8–12.