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Effect of Reducing the Dosage of NPK Fertilizer from the Ruled Dosage on Photosynthesis Activity, Yield and Yield Quality of Corn (*Zea Mays* L.)

Albina Jelita[1], I Nyoman Rai[2], Ni Nyoman Ari Mayadewi[3]

[1]Student of Master Program in Dryland Agriculture, Faculty of Agriculture, Udayana University, Denpasar, Bali, Indonesia

[2,3]Agronomy and Horticulture Laboratory, Faculty of Agriculture, Udayana University, Denpasar, Bali, Indonesia

ABSTRACT: Maize yield and quality can be improved by paying attention to the type and dose of fertilizer. Excessive use of chemical fertilizers can cause the soil to become degraded and make the soil vulnerable to erosion. A decrease in soil quality will affect plant growth and productivity. The purpose of this study was to find the percentage of NPK dose reduction, find differences in photosynthetic activity, yield and quality of corn crops. This study used a 2-factor Randomized Group Design (RAK). The results showed that the effect of reducing the dose of NPK fertilizer at 10% can increase photosynthetic yields such as reducing sugar content of 7.66 and at a dose reduction of 20% can increase the length of the cob of corn plants which is 19.51 cm. The results of data analysis showed that a 10% reduction in NPK dosage showed that the highest seed weight of 14% water content per plant was obtained at a 10% reduction in NPK fertilizer dosage, which was 189.53 grams per plant.

KEYWORDS: Recommended dosage, Reduced NPK fertilizer, Photosynthesis, Yield and Yield Quality

INTRODUCTION

Maize (*Zea mays* L.) is an important food crop besides wheat and rice. Maize is a source of carbohydrates that can be utilized as food and industrial raw materials. Maize can also be utilized as animal feed, a source of vegetable oil and raw material for maize flour or cornstarch. According to the Official Statistics Agency No. 69/10/Th. XXVI, October 16, 2023 (BPS, 2023) the production of dry shelled maize with a moisture content of 28% from January to December 2023 amounted to 19.56 million tons, a decrease of 2.80 million tons or 12.50% compared to 22.36 million tons in 2022. Maize productivity is calculated per unit of land and is influenced by several factors, one of which is the use of fertilizer in maize cultivation. Increasing corn production can be done in various ways, one of which is through increasing soil fertility, namely by fertilizing [2]. Fertilization aims to get better growth and development and improve soil fertility and add macro and micro nutrients in the soil. The yield and quality of corn plants can be improved by paying attention to the type and dose of fertilizer.

Fertilization is essential for the growth and development of maize plants. Farmers in Indonesia use inorganic fertilizers in their crop cultivation to maximize crop yields, but the use of inorganic fertilizers over a long period of time generally has an adverse effect on soil conditions [6]. Factors that affect the growth and yield of maize plants include the type of fertilizer used and the dose of fertilizer.

One of the main factors for the lack of maize productivity is the use of excessive doses and concentrations of chemical fertilizers that are not in accordance with the recommended use. In order to avoid excessive fertilization and not reduce soil fertility capacity, it is necessary to apply a balanced NPK 15-15-15 compound fertilizer. The function of nutrients in NPK 15-15-15 fertilizer is that plant growth and yield can increase. NPK 15-15-15 fertilizer contains the nutrient N Nitrogen which is able to help the growth of leaves, the nutrient P (phosphorus) is able to grow in the form of roots and shoots, and the nutrient K (potassium) which helps the flowering and fruiting process [11]. Farmers previously used NPK fertilizers excessively and not as recommended, causing the soil to become degraded and making the soil vulnerable to erosion. A decrease in soil quality will affect plant growth and productivity. Excessive use of NPK, besides being inefficient, can also have a negative impact on soil productivity, crop yields, and can even damage agricultural land [7].

The application of fertilizer to corn plants is also one of the factors in the rate of photosynthesis process to help have green leaf substances (chlorophyll) in plants. Nitrogen is the content of nutrients present in the three inorganic fertilizers used. Nitrogen plays an important role for the vegetative growth of plants, one of which is the leaves, namely in the process of photosynthesis

and helps plants produce leaf green substances (chlorophyll) [4]. Plant growth is closely related to the number of leaves, chlorophyll content and photosynthesis rate. Nitrogen application can increase the number of stomata which affects the density of stomata, so it can increase the rate of transpiration and absorption of CO2 for photosynthesis.

RESEARCH METHODS

The research was conducted at Subak Kerdung, Moyo Island Road, Pedungan Village, South Denpasar District. This research was conducted from June to October 2024. implemented in May to October 2024. The research location is at an altitude of 5 m above sea level. Materials and tools used were corn seeds Bisi 18, N P and K fertilizers, SPAD, ruler, micrometer, scales, knife, sprayer, pesticide, tractor, tray, tools to measure relative water content (KAR) and hoe.

This study used a 1-factor Randomized Group Design (RAK) with 12 replications. The factor of reducing the dose of N P and K fertilizers consists of 5 levels, namely, the recommended dose or the farmer's method (P0), the recommended dose is reduced by 10% (P1), the recommended dose is reduced by 20% (P2), the recommended dose is reduced by 30% (P3), the recommended dose is reduced by 40% (P4). The recommended dose of fertilization is according to the recommended dose / farmer's method, (Phonska plus 15-15-15 350 kg / ha and Urea 250 kg / ha, P1 recommended dose reduced by 10% (Phonska Plus 15-15-15 315 kg / ha and Urea 225 kg / ha), P2 recommended dose reduced by 20% (Phonska Plus 15-15-15 280 kg/ha and Urea 200 kg/ha), P3 recommended dose reduced by 30% (Phonska Plus 15-15-15 245 kg/ha and Urea 175 kg/ha), P4 recommended dose reduced by 40% (Phonska Plus 15-1515 210 kg/ha and Urea 150 kg/ha).

At the initial stage of tillage, 5 plots were selected with an area of approximately 2.5 acres each according to the treatment level. The placement of P0, P1, P2, P3 and P4 were randomized in such a way and then given a code / sign. Tillage was done with a mini tractor. The planting distance used was 40 cm x 75 cm with 2 seeds per hole. Phonska and Urea fertilization were applied to all main factors (P0, P1, P2, P3, P4). The application of Phonska Plus was done as recommended for corn, which was only given once for the entire recommended dose at 7 hst (350 kg/ha), while the application of Urea was done twice, partly at the age of 25 hst (125 kg/ha) and partly at the age of 50 hst (125 kg/ha). In the P0 plot, Phonska 15-15-15 fertilizer at a dose of 350 kg/ha was applied once for all doses at the age of 7 hst, while the application of urea was carried out twice at the age of 25 and 50 hst at a dose of 125 kg/ha each. In the P1 plot, Phonska 15-15-15 fertilizer at a dose of 315 kg/ha was applied once for all doses at the age of 7 hst, while urea application was carried out twice at the age of 25 and 50 hst at a dose of 112.5 kg/ha each. In P2 plots, Phonska 15-15-15 fertilizer at a dose of 280 kg/ha was applied once for all doses at the age of 7 hst, while urea application was carried out twice at the age of 25 and 50 hst at a dose of 100 kg/ha each. In the P3 plot, Phonska 15-15-15 fertilizer at a dose of 245 kg/ha was applied once for all doses at the age of 7 hst, while urea application was carried out twice at the age of 25 and 50 hst at a dose of 87.50 kg/ha each. In plot P4, Phonska 15-15-15 fertilizer at a dose of 210 kg/ha was applied once for all doses at the age of 7 hst, while urea was applied twice at the age of 25 and 50 hst at a dose of 75 kg/ha each. Maintenance of the research plants such as irrigation, weeding, pest and disease control will be carried out intensively in a manner similar to how farmers usually do. Harvesting is done when the corn kernels have met the criteria of being ready to harvest, i.e. the kernels are physiologically mature or the kernels no longer receive photosynthate from the leaves. The physical criteria for harvesting maize are that the kelobot is yellow, the kernels are hard and the color of the kernels is shiny, if pressed with the thumb there are no pressure marks on the kernels. The harvested cobs were shelled, then the quality was observed to know the effect of the treatment given. The variables observed in this study were plant height, leaf number, leaf color, leaf chlorifl content, relative water content, nutrient content of nitrogen, phosphorus, potassium, total sugar content, reducing sugar, leaf sucrose, number of seeds per plant, seed weight of 14% water content per plant, percentage of pithy seeds.

RESULTS

Plant Height, Leaf Number, Leaf Color

In the treatment of reduced NPK fertilizer, the highest plant height was obtained in P0 which was as high as 267.52 cm and significantly different from the treatment of P1, P2, and P4. The lowest plant height was obtained in P3 treatment with a value of 241.75 cm. The treatment of reduced NPK fertilizer had the highest number of leaves in P4 with a value of 14.13 strands and significantly different from P0, P1 and P3. The lowest number was found in P2 with 11.47 leaves.

The treatment of reduced NPK fertilizer, the highest leaf color is found in P4 (4.80) Bwd which is not significantly different from P0 and P1 except P2 and P3 which are significantly different from the others. The lowest leaf color was found in P3 with a value of 3.91 Bwd.

Table 1. Plant height, leaf number, leaf color

NPK Fertilizer Reduction	Plant Height (cm)	Number of Leaves (blade)	Leaf Color (BWD unit)
P0	267.52 a	13.52b	4.65 a
P1	257.66 b	13.38b	4.59a
P2	258.41 b	11.47d	4.31b
P3	241.75 c	12.94c	3.91c
P4	258.72 b	14.13a	4.80a
BNT 5%	7.92	0.36	0.36

Notes: Numbers that have the same letter in the same column indicate that they are not significantly different at the 5% level of the least significant difference test (BNT).

Leaf Chlorophyll Content, Relative Water Content %

The treatment of reducing the dose of NPK fertilizer, the highest value is found in the treatment P0 (43.60) SPAD which is not significantly different from the others. Meanwhile, the lowest value was found in the P4 treatment (42.62) SPAD.

Treatment of NPK fertilizer reduction, the highest value of KAR was found in the reduction of 20% NPK fertilizer dose (P2) with a value of 88.89% which was significantly different from the others. The lowest value of KAR was found in the reduced dose of 30% (P3) with a value of 84.67%.

Table 2. Leaf Chlorophyll Content (SPAD), Relative Water Content (KAR) %

NPK Fertilizer Reduction	Leaf Chlorophol Content (SPAD)	Relative Water Content (KAR)
P0	43.60a	87.50a
P1	43.29a	88.39a
P2	42.72a	88.89a
P3	42.75a	84.67b
P4	42.62a	85.50a
BNT 5%	1.26	4.07

Notes: Numbers that have the same letter in the same column indicate that they are not significantly different at the 5% level of the least significant difference test (BNT).

NPK nutrient content.

The results of the analysis shown in Table l show that the Nitrogen (N) network has the highest results in P2 with a value of 2.520, the Phospor (P) network has the highest results in the reduced dose of 40% (P4) with a value of 0.42, the Potassium (K) network has the highest results in the reduced dose of NPK fertilizer 40% (P4) with a value of 0.565.

Table 3. Nutrient content of Nitrogen, Phospor, Potassium

Fertilizer Dosage	Nitrogen (%)	Phospor (%)	Potassium (%)
P0	2.940	0.37	0.450
P1	2.380	0.40	0.485
P2	2.520	0.41	0.515
P3	2.170	0.40	0.505
P4	2.030	0.42	0.565
Total	12.040	1.99	2.52

Description: Numbers that have the same letter in the same column indicate that they are not significantly different at the 5% level of the least significant difference test (BNT).

Total Sugar, Reduction and Sucrose Content of Leaves

The results of the analysis show that the highest results in total sugar are found in P0 with a value of 12.18. Reduced sugar gets the highest result in P1 with a value of 7.66. The highest result of leaf sucrose is in P0 with a value of 5.56.

Table 4. Total sugar, reducing and sucrose sugar content of leaves

Fertilizer Dosage	Total Sugar	Reduction	Leaf Sucrose
P0	12.18	6.62	5.56
P1	8.80	7.66	1.14
P2	9.59	7.48	2.115
P3	7.77	6.36	1.42
P4	8.85	7.20	1.65
Total	47.19	35	11.885

Notes: Numbers that have the same letter in the same column indicate that they are not significantly different at the 5% level of the least significant difference test (BNT).

Number of Seeds per Plant, Weight of 14% Water Content Seeds per Plant, Percentage of Seeds Whole

The treatment of reduced doses of NPK fertilizer, the highest yield was found in P1 (572.26) seeds which were significantly different from the others. While at P4 (539.71) seeds showed the lowest results. The treatment of reduced doses of NPK fertilizer, the highest yield was found in P1 (189.53 g) which was significantly different from P0, P2 P3 and P4 whose results were the lowest with a value of 170.94 (g). In the treatment of reduced doses of NPK fertilizer, there were significantly different values from all treatments P0 (96.69%), P1 (96.18%), P2 (95.74%), P3 (95.74%) and P4 (95.28%). The highest value is found in the P0 treatment and the lowest value is found in the P4 treatment.

Table 5. Number of seeds per plant, weight of seeds at 14% moisture content per plant, percentage of kernel seeds

Reduced dosage of NPK Fertilizer	Number of Seeds Per Plant (Grains)	Seed Weight 14% Water Content Per Plant	Percentage of Numbered Seeds
P0	560.19 a	174.31 a	96.69 a
P1	572.26 a	189.53 a	96.18 a
P2	568.33 a	189.22 a	95.74 a
P3	561.09 a	178.06 a	95.74 a
P4	539.71 b	170.94 a	95.28 a
BNT 5%	29.32	12.51	1.98

Notes: Numbers that have the same letter in the same column indicate that they are not significantly different at the 5% level of the least significant difference test (BNT).

DISCUSSION

The highest weight of 14% water content seeds per plant was obtained at a reduced dose of 10% NPK fertilizer (P1) which was 189.53 grams per plant or increased by 8.73% compared to the weight of 14% water content seeds at P0 with a value of 174.31 grams, although statistically not significantly different. The seed weight of 14% water content per plant is also correlated with the number of seeds per plant (r = 0.92*) which means that, the more the number of seeds per plant or per cob, the higher the seed weight of 14% water content per plant. This is supported by the high Relative Water Content (KAR) in the treatment of reducing the dose of NPK fertilizer 2% (P2) with a value of 88.89 which is 2% higher than the control (P0). Relative water content is one of the important factors in the physiological growth of plants so that the photosynthate produced can be translocated properly. When the water content contained in plants is good, nutrients can be dissolved well and also the photosynthesis process for carbohydrate formation is also getting better. When the photosynthesis process runs smoothly, the rate of vegetative growth of plants runs quickly [3]. Water has an important function for plants as a basic material that will be used in the process of photosynthesis of plants for the formation of carbohydrates [5]. This is related to the results of the highest reducing sugar in P1 with a value of 7.66, 16% higher than the recommended dose, the higher the reducing sugar, the more starch is produced so that it can increase seed weight. The high seed weight of 14% water content per plant is supported by the Phospor and potassium network contained in corn plants which shows that reducing the dose of NPK fertilizer does not affect the Phospor and Potassium network contained in corn plants. The content of Phospor contained in corn plants at a reduced dose of 40% NPK fertilizer (P4) has a value of 0.42 or 14% higher than the control dose (P0) while the Potassium network has a value of 0.65, 24% higher than P0. Phospor is needed by plants as a constituent element of protein needed for flower formation, cob formation, and accelerating

seed ripening [10]). The generative phase of cob formation required by corn plants is the element P [9]. The nutrient Phospor also functions as an element that encourages plants towards the generative phase [8]. Reducing the dose of NPK fertilizer by 10% can increase the K element in the soil. P and K elements are the most important elements for maximum corn plant growth. P elements can function for seed maturation while K elements function for root development so as to facilitate the absorption of nutrients and water [1].

CONCLUSIONS

Reducing the dose of NPK fertilizer at 10% can increase photosynthetic yield in the form of reducing sugar content of 7.66% and at a dose reduction of 20% can increase the length of the cob of corn plants which is 19.51 cm. Reduction of NPK fertilizer dosage at 10% also shows that the highest seed weight of 14% water content per plant is obtained at a reduced dose of 10% NPK fertilizer, which is 189.53 grams per plant.

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