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(RESEARCH ARTICLE)

Effect of reduction of NPK pupuku from RDA dosage and application of keratin hidrolizate peptida on growth and results of corn plant *(Zea mays* L.)

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Abstract

Corn *(Zea mays* L.) is one of the food crops as a source of carbohydrates, corn can also be an alternative source of food in Indonesia. Corn to grow well requires nutrients such as NPK fertilizer. Excessive use of NPK fertilizers will also have a negative impact on the environment such as groundwater pollution, therefore it is necessary to try to reduce the use of NPK fertilizers without reducing the yield of corn plants. This study aims to find a percentage reduction in NPK doses that does not reduce growth, yield and quality of yield in corn plants, find differences in growth, yield and quality of yield of corn plants between given and not given peptides and find interactions between reduced doses of NPK fertilizers and peptide administration that provide growth, yield and quality of yield in the best corn plants. This study used a randomized group design (RAK) *split plot* with the main treatment, namely a reduction in the dose of NPK fertilizer, which consisted of 3 treatment levels, namely fertilization according to the recommended dose, the recommended dose was reduced by 20% and the recommended dose was reduced by 40% and the subplots consisted of 2 levels, namely spraying with peptides and spraying without peptides. The results showed that reducing the dose of NPK fertilizer by 20% gave the highest yield of 14% water content seeds ton/ha (13.74 ton/ha) compared to the other treatments. Treatment with peptide spraying gave the best growth and yield compared to no peptide spraying. The interaction between the treatment of fertilizer dose reduction with peptide spraying occurred in the variables of plant height, leaf chlorophyll, leaf color, weight per seed and number of seeds per plant.

Keywords: Dosage; Corn; Peptides

1. Introduction

Corn *(Zea mays* L.) is one of the food crops besides wheat and rice. as a source of carbohydrates, corn can also be an alternative source of food in Indonesia. Corn as one of the many food agricultural commodities that we can find in Indonesia because in addition to being a staple food corn can also be used for animal feed such as corn scraps and can also be used for industrial activities. Corn also requires nutrients for its survival, therefore in order to get a good harvest, it needs the elements of nitrogen (N), phosphorus (P), and potassium (K) which are commonly used such as NPK fertilizers.

Excessive use of NPK fertilizers will also have a negative impact on the environment such as groundwater pollution, therefore it is necessary to reduce the use of NPK fertilizers without reducing the yield of corn plants. Continued use of chemical fertilizers can result in soil hardening and loss of porosity due to increased acid levels. One alternative that can be used to reduce the use of chemical fertilizers is to utilize natural ingredients.

Keratin Hydrolyzate Peptide is a product (KHP) made from agricultural waste, namely fish scales and poultry feathers. Fish scales and feathers are the main waste production from the poultry industry and aquaculture, currently fish scales and feathers have bioprotective structural protein sources such as collagen and keratin. Feathers and fish scales are agricultural materials that are high in protein, carbon-free and recyclable. Poultry feathers have a keratin content of 85-

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91% and contain 13-15% organic nitrogen, 1.6-2.0% organic sulfur, and are higher than the biological material. Poultry feathers are rich in three sulfur-containing amino acids, cysteine, and cystine and methionine. Peptides composed of sulfur-containing amino acids can play an important role in improving the physiological accumulation, development, defense, and taste of all plants. Meanwhile, fish scales contain 45% collagen and are rich in glycine (30%), proline (25%), and hydroxyproline (12%), which is unique among other biological materials.

2. Materials and Methods

The research materials used were corn seeds of hybrid variety Bisi 18, as well as fertilizers such as Urea, Phonska Plus 15-15-15, compost, peptides, Golden Grow from CH Biotech R&D Co. Ltd. Taiwan (2023). The research tools used were tractors, hoes, rakes, SPAD chlorophyll meters, *munsell plant tissue color charts*, *lux meters*, rulers, trays, equipment for measuring relative water content (KAR) of leaves, equipment for soil fertility analysis, analysis of N, P, and K nutrient content of leaves, and equipment for analyzing total sugar content, reducing sugar, and sucrose.

The research took place from June to October 2024, in farmers' fields, located in Subak Kerdung, Jalan Pulau Moyo, Pedungan Village, Denpasar. Then further researched at the Agronomy and Horticulture Lab, Udayana University.

This study used a two-factor *split plot* group randomized design repeated six times. as the main plot was a reduced dose of NPK fertilizer (P). The second factor was the application of *keratine hydrolyzate Peptide* (K). Variables observed included plant growth, yield and quality, and soil fertility before and after treatment.

2.1. Preparation of BC 18 corn seed 1 cob

Maize seeds used for research before planting were soaked for 4 hours with GG solution (1 ml GG/1 liter of water/1 kg of seeds), then air dried. One day after soaking the seeds were planted. At the age of 7 days since the seeds were planted, the plants were sprayed again evenly with 1 ml GG/1 liter of water.

2.2. Tillage and plotting

At the initial stage of tillage, 10 plots with an area of approximately 2.5 acres each were selected according to the main plot treatment levels P0, P2and P4. The three selected plots must be relatively homogeneous in terms of soil type, soil fertility, irradiation, irrigation water source, land slope, and cultivated by one landowner so that the history of land use is relatively homogeneous (in this study, homogeneous plots such as the above requirements have been obtained at Farmer's Farm, located in Subak Kerdung, Jalan Pulau Moyo, Denpasar). After that, the placement of P0, P2,and P4were randomized in such a way that they were given codes/placards. Tillage was done with a mini tractor. After completion of tillage, each main plot was divided into 2 blocks, for the placement of Pt and Pd, so that the layout of experimental units in the field.

2.3. Planting

Seeds after soaking with Golden Grow were planted the day after soaking. The planting distance used was 40 cm x 75 cm with 3 seeds per hole.

2.4. Peptide and NPK fertilizer application

Spraying of peptides in P0d, P2dand P4dwas carried out at a concentration of 2 ml/l in the V5 phase (vegetative phase 5 leaves are fully open), Vt phase (transition phase from vegetative to reproductive/tasseling) and R2 phase (blister phase which is 10-14 days after silking), while in the t code the plants were not sprayed with peptides. Plants were sprayed until the crown was evenly exposed. Phonska and Urea fertilization were applied to all main factors (P0, P(2,) P(4)). The application of Phonska Plus was done as recommended for maize, 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). Based on the dosage of Phonska 15-15-15 and Urea fertilizers according to the treatment levels P0, P2,and P4and the distribution of the application according to the growth phase of the corn plant.

2.5. Harvest and post-harvest

Harvesting is done when the corn kernels have met the criteria of being ready to harvest, i.e. the kernels are physiologically mature. The criteria for harvesting corn physically 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 observations were made on the quality and quality to find out the effect of the treatment given.

2.6. Observation Variables

2.6.1. Soil fertility analysis before and after the study

The analysis was carried out in the Soil Science laboratory of the Faculty of Agriculture, Udayana University. Before the study, the number of samples analyzed was only 1 sample with 3 replicates while after the study, 6 samples with 3 replicates will be analyzed. Soil samples at the beginning of the study were taken from the main plots P0t, P(0d,) P(2t,) P(2d,) P(4t)and P4dwith standardized collection methods, then the samples were composited into 1 sample. The mixture was chemically analyzed. After the research, soil samples from the main plots P0t, P(0d,) P(2t,) P(2d,) P(3t,)and P4dwere taken individually and then the samples were separated individually as well because the soils in the main plots had received different fertilizer and peptide treatments so they had to be tested separately to determine whether the decrease in fertilizer use due to no peptide application and peptide application decreased soil fertility or not.

2.6.2. Plant height (cm)

Observed on randomly selected sample plants every 2 weeks until maximum height. The first observation was made 2 weeks after the seeds were planted (MSBD).

2.6.3. Leaf chlorophyll content (SPAD)

Measured on sample plants 3 times using the Chlorophyll Meter SPAD tool each 2 weeks after the administration of peptides I, II, and III, then averaged.

2.6.4. Relative water content (KAR) of leaves (%)

Relative Water Content (RWC) *of leaves* was measured by performing the following steps: Some of the leaf samples were cut with scissors, then wrapped in airtight plastic and put in a thermos filled with ice and brought to the Agronomy and Horticulture Laboratory, Faculty of Agriculture, Udayana University. In the laboratory, leaf samples were then cut into small pieces with a size of 1x1 cm, then weighed fresh weight (BS). After weighing, it was put into a cup filled with water and irradiated with 40 watts of fluroscent light at a distance of 30 cm at room temperature for 5 hours, then removed. Water that is still attached is carefully cleaned using tissue paper and then weighed turgid weight (BT). After weighing the leaf samples, they were dried using an oven at 70^{o}C until the weight was stable/not decreasing, then the dry weight (BK) was weighed. KAR value was calculated by the formula:

$$\text{KAR (\%)} = \frac{\text{fresh weight (FW)} - \text{dry weight (DW)}}{\text{turgid weight (TW)} - \text{dry weight (DW)}} \text{ X } 100\%$$

Nutrient content of N, P, and K of leaves (%)

Analysis of leaf N, P and K nutrient content was carried out by taking leaf samples 3 times, namely 1 week after the application of péptida I, II and III. Leaf samples at each collection were oven at 70 ^{0}C until constant, then crushed into flour and composited. The composited leaf samples were measured for N, P and K using a distillator to obtain total N through the Kjaldahl Semi-micro method, while for total P and K elements using a Spectrophotometer.

2.6.5. Number of seeds per cob (grains)

This was done by shelling the seeds from each ear of the sample plants after harvest and then counting the number of seeds using a counter. The number of seeds was counted manually.

Dry seed weight per plant (g)

Measure by weighing the shelled seeds after harvesting the sample plants, then calculate the average. The tool used is a scale.

2.6.6. Seed weight at 14% moisture content per plant (g)

Measured by drying the harvested dry maize kernels from the sample plants until they reach a moisture content of 14% (the moisture content of maize kernels that meet trade quality standards) and then weighing them to obtain the weight of dry kernels with a moisture content of 14%.

2.6.7. Weight per kernel (g)

Measured by taking lots of seeds from each treatment then randomly selecting 100 seeds and weighing them. Weight per seed was calculated by dividing the weight of 100 seeds by 100 seeds.

3. Results and Discussion

3.1. Soil Fertility Analysis Results

The results of the analysis of pH (H2O) content in Table 1 were highest in the treatment combination of P0Kt and P0Kd which amounted to 6.81, while the lowest was found in the treatment of P2Kt. The results of the analysis of DHL content showed that the highest value was obtained in the treatment combination of P2Kd which amounted to 0.64 mmhos/cm, while the lowest was found in the treatment of P0Kd. The results of the analysis of C-organic content showed that the highest value was obtained in the treatment combination of P0Kt which amounted to 3.16%, while the lowest was found in the treatment of P4Kd. The results of the analysis of Total N content showed that the highest value was obtained in the treatment combination of P0Kd which amounted to 0.27%, while the lowest was found in the treatment of P4Kt. The results of the analysis of Available P content showed that the highest value was obtained in the treatment combination of P2Kt.which amounted to 79.28 ppm, while the lowest was found in the P0Kt. treatment. The results of the analysis of Available K content showed that the highest value was obtained in the P2Kt treatment combination which amounted to 571.58 ppm, while the lowest was found in the P0Kt. treatment. The results of the analysis of the content of KU Water Content showed that the highest value was obtained in the treatment combination P4Kt which amounted to 26.61%, while the lowest was found in the treatment P2Kt.

Table 1 Soil fertility test results

Sample code	pH	DHL	C Organik	N Total	P Available	K Available	Water Content
	H2O	(mmhos/cm)	(%)	(%)	(ppm)	(ppm)	KU (%)
Tanah awal	6.410	2.050	1.680	0.180	48.200	511.350	7.630
P_0K_t	6.810	0.490	3.160	0.260	31.380	490.860	25.060
P_0K_d	6.810	0.580	2.770	0.270	45.930	529.110	22.310
P_2K_t	6.180	0.630	3.070	0.240	79.280	571.580	21.200
P_2K_d	6.620	0.640	2.640	0.240	53.690	537.490	25.370
P_4K_t	6.570	0.500	2.130	0.120	43.610	556.730	26.610
P_4K_d	6.630	0.440	2.060	0.220	59.200	520.000	22.180

Plant Height, Leaf Chlorophyll, Weight per Seed, Number of seeds per cob

The results in Table 2 show that plant height in the treatment of peptides and reduced doses of fertilizer showed interaction results, the treatment level P0Kd obtained a value that tended to be higher at 273.00 cm compared to other treatments, but was not significantly different from the treatment levels P2Kd and P4Kt.

The results in Table 2 show that the chlorophyll content of leaves treated with peptides and reduced fertilizer doses showed interaction results, the treatment level P2Kd obtained a value that tended to be higher at 44.37 SPAD compared to other treatments, but significantly different from P0Kd, P0Kt and P4Kt.

The results in Table 2 show that the weight per seed in the treatment of peptides and without peptides and reduced doses of fertilizer showed an interaction, the treatment levels P2Kd and P2Kt obtained values that tended to be higher at 0.41 g than other treatments, and significantly different from all treatment levels P0Kd and P4Kt.

The results in Table 2 show that the Number of seeds per cob in the treatment of peptides and reduced doses of fertilizer showed interaction results, the treatment level P_2K_d obtained a value that tended to be higher at 594.57 grains than other treatments, significantly different from all treatment levels P_4K_t.

Table 2 Interaction between Peptide Treatment (K) and Reduction of Fertilizer Dosage (P) on Variables of Plant Height, Leaf Chlorophyll, Weight per Seed, Number of seeds per cob

Treatment	Plant Height (cm)	Leaf Chlorophyll (SPAD)	Weight per Seed (g)	Number of seeds per cob (grains)
P_0K_t	256.22 b	43.67 c	0.39 a	550.98 a
P_0K_d	273.00 a	42.88 b	0.37 c	576.48 a
P_2K_t	250.39 b	41.63 a	0.41 a	561.85 a
P_2K_d	270.56 a	44.37 a	0.41 a	594.57 a
P_4K_t	261.33 ab	42.16 b	0.37 bc	533.04 b
P_4K_d	259.22 b	43.31 ab	0.40 a	580.64 a

Notes: Numbers followed by the same letter indicate not significantly different in Duncan's 5% multiple range test.

Number of Leaves, Relative Water Content, Harvested Dry Seed Weight Per Plant and Harvested Dry Seed Weight Per Plant

In the variable number of leaves of peptide treatment (K) contained in Table 3, treatment K_d obtained a value that tended to be higher at 13.29 strands and significantly different from the treatment level K_t. In the treatment of reduced fertilizer dose (P), treatment P_4 obtained a value that tended to be higher among the other treatments with an average value of 13.97 strands, significantly different from treatment P_0 (13,39 strands) and P_2 11.72 strands).

In the relative water content variable of the peptide treatment (K) contained in Table 3, the K_d treatment obtained a value that tended to be higher, with an average value of 88.41% and was not significantly different from the K_t treatment level. In the treatment of reduced fertilizer dose (P), treatment P_2 obtained a value that tended to be higher among other treatments with an average value of 88.83% but was not significantly different from treatment P_0 (88,14%) and P_4 (85,72%).

In the dry seed weight variable per plant of peptide application (K) contained in Table 3, the K_d treatment obtained a value that tended to be higher, with an average value of 224.69 g and significantly different from the K_t treatment level. In the treatment of reduced fertilizer dose (P), treatment P_2 obtained values that tended to be higher among the other treatments with an average value of 234.97 g, and significantly different from treatment perlakuan P_0 (215,42 g) and P_4 (205,89 g).

In the variable seed weight of 14% water content per plant of peptide application (K) contained in Table 3, treatment K_d obtained a value that tended to be higher, with an average value of 181.15 g and was not significantly different from the level of treatment K_t. In the treatment of reduced doses of fertilizer (P), treatment P_2 obtained values that tended to be higher

among other treatments with an average value of 191.03 g, and significantly different from treatment P_0 (172,14 g) dan P_4 (173,56 g).

Table 3 Effect of Peptide Application (K) and Reduction of Fertilizer Dosage (P) on Variable Number of Leaves, Relative Water Content, Harvested Dry Seed Weight Per Plant (g) and 14% Water Content Seed Weight Per Plant (g)

Treatment	Number of Leaves (blade)	Relative Water Content (%)	Harvested Dry Seed Weight Per Plant (g)	Seed Weight at 14% Water Content Per Plant (g)
Peptide Application (K)				
K_d	13.29 a	88.41 a	224.69 a	181.15 a
K_t	12.75 b	86.72 a	212.83 b	176.15 a
BNT 5%	0.35	3.41	11.74	13.51
P_0	13.39 b	88.14 a	215.42 b	172.14 b
P_2	11.72 c	88.83 a	234.97 a	191.03 a
P_4	13.97 a	85.72 a	205.89 b	173.56 b
BNT 5%	0.49	3.72	11.33	14.31

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

3.2. NPK Nutrient Content

The results of the analysis of leaf N nutrient content in Table 4 were highest in the treatment combination P_0K_t which amounted to 3.150%, while the lowest was found in the treatment P_4K_t. When viewed from the reduction of the fertilizer dose, it can be seen that P_0 provides the highest N nutrient content of an average of 2.940%, followed by treatment P_2. Meanwhile, when viewed from the treatment of peptide administration, it can be seen that the $K_t$treatment gives the highest results compared to the $K_d$treatment, which is 2.543%.

Table 4 Effect of Reduction of Fertilizer Dosage from Recommended Dosage + Peptide Administration on Leaf N Nutrient Content

Fertilizer Dosage	Peptide Administration		Total	Average
	Kt	Kd		
P_0	3.150	2.730	5.880	2.940
P_2	2.590	2.450	5.040	2.520
P_4	1.890	2.170	4.060	2.030
Total	7.630	7.350		
Average	2.543	2.450		

The results of the analysis of leaf P nutrient content in Table 5 were highest in the treatment combination of P2Kd, P4Kt and P4Kd which amounted to 0.42%, while the lowest was in the treatment of P0Kt. When viewed from the reduction of the fertilizer dose, it can be seen that P4provides the highest P nutrient content of 0.42% on average. Meanwhile, when viewed from the peptide treatment, it can be seen that the Kd treatment gives greater results than the Kt peptide treatment with an average value of 0.41%.

Table 5 Effect of Reduction of Fertilizer Dosage from Recommended Dosage + Peptide Administration on Leaf P Nutrient Content

Fertilizer Dosage	Peptide Administration		Total	Average
	Kt	Kd		
P0	0.36	0.38	0.74	0.37
P2	0.39	0.42	0.81	0.41
P4	0.42	0.42	0.84	0.42
Total	1.17	1.22		
Average	0.39	0.41		

The results of the analysis of leaf K nutrient content in Table 6 were highest in the treatment combination P2Kd which amounted to 0.58%, while the lowest was in the treatment P0Kt. When viewed from the reduction of the fertilizer dose, it can be seen that P4provides the highest K nutrient content of 0.57% on average. Meanwhile, when viewed from the treatment of peptide administration, it can be seen that the Kdtreatment gives greater results than the Kt treatment with an average value of 0.54%.

Table 6 Effect of Reduction of Fertilizer Dosage from Recommended Dosage + Peptide Administration on Leaf K Nutrient Content

Fertilizer Dosage	Peptide Application		Total	Average
	Kt	Kd		
P0	0.44	0.46	0.90	0.45
P2	0.45	0.58	1.03	0.52
P4	0.56	0.57	1.13	0.57
Total	1.45	1.61		
Average	0.48	0.54		

4. Conclusion

Based on the results of the study, the following conclusions can be drawn:

- Reduction of NPK dosage affects the growth, yield, and quality of corn plants.
- Reduction to 20% gave the highest yield of 14% water content kernels (13.74 tons/ha) compared to other treatment levels.

Treatment with Keratin Hydrolyzate Peptide can increase the growth and yield of corn plants, which is indicated by the highest weight of 14% water content seeds per plant which is 181.15 g, the highest plant height which is 273.00 cm, stem which is 10.89 pieces, number of leaves which is 13.29 and stem diameter which is 2.33 cm.

There is an interaction between the treatment of reducing the dose of fertilizer with the provision of peptides occurs in the variables of plant height, leaf chlorophyll, weight per seed and the number of seeds per cob. The combination of fertilization treatment according to the recommended dose with keratin hydrolyzate peptide gave the best value on the variable of corn plant height which was 273.00 cm. The treatment combination of reducing the fertilizer dose by 20% with keratin hydrolyzate peptide gives the best value on the number of seeds per plant, which is 594.57 grains. The treatment combination of a 20% reduction in fertilizer dose with keratin hydrolyzate peptide and a treatment combination of a 20% reduction in fertilizer dose without keratin hydrolyzate peptide gave the best value on the weight per seed variable, which was 0.41g

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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