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The Effect of Plant Density and Nitrogen Fertilizer (N) on the Growth and Yield of Paprika Crops

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Abstract: Peppers (Capsicum annum var. Grossum L.) originally from the subtropical regions of Central America and is not native to Indonesia. Peppers are used as a food ingredient for cooking. The productivity of paprika plants in Indonesia has not reached its potential due to several influencing factors including environmental factors. One of the efforts to increase the productivity of peppers is by regulating planting distances and applying balanced nitrogen fertilizers. This research has been conducted for 5 months, namely Apri 2020 - August 2020 in Noongan, West Langoan District, Minahasa Regency, North Sulawesi Province. The research land is at an altitude of 600 m above sea level, with a temperature of 24 – 260 C. Materials used during the study were red pepper seeds, soil, compost, nitrogen fertilizer (Urea). The tools used in this study were 9 kg polybags, meters, stationery, scissors, cameras, analytical scales, and sieves. The materials used during the study were red pepper seeds, soil, compost, urea fertilizer (N) and water. The study using a Randomized Group Design was repeated 3 times so that 48 experiments were obtained. The treatment plots of this study are: N0: No nitrogen fertilizer (urea), N1: Nitrogen fertilizer 50 kg/ha, N2: Nitrogen fertilizer 100 kg/ha, N3: Nitrogen fertilizer 150 kg/ha and K1: 20 x 20 Cm, K2: 30 x 30 cm, K3: 40 x 40 cm, K4: 50 x 50 cm . If there is a real different influence on the treatment, it is continued by using the BNT (Smallest Real Difference) test with a level of 5%. The objectives of this study are: 1. To determine the best level of plant density on plant growth and yield. 2. Knowing the effect of the interaction between plant density and nitrogen fertilizer on the growth and yield of paprika plants. Observations made include: Plant height, number of leaves, weight of segar fruit per plant and per hectare. Based on the results of research on planting wine that is suitable for plant growth such as plant height and number of leaves and the yield of paprika fruit is at a plant distance of 40 X 40 cm with urea fertilizer of 150 kg / ha. Likewise, the fresh weight of planting and perhektar is found in the same treatment, namely the N3K3 treatment (urea fertilizer 150 kh / ha and planting distance 40 X 40 cm) which gives the highest yield.

Keywords: Paprika, Urea, Planting distance.

INTRODUCTION

Peppers (*Capiscum annum,* L. Var. grossum) come from the subtropical regions of Central America and are not native to Indonesia. Peppers are a vegetable commodity that is quite important because it has economic value and high nutritional content. Peppers are not spicy because they have almost no capsicin substance ($C_9H_{12}O_2$) but rather tend to be sweet so they are called sweet pappers. Peppers are commonly used as a flavoring ingredient or salad (Prihmantoro and Indriani, 1995).

The productivity of paprika crops in Indonesia is still quite low at only 5 tons per hectare while in America it reaches 59.6 tons per hectare (Haryono, 2004). Agriculture in America is already taking advantage of advanced agricultural technology. The low production in Indonesia is mainly due to the management of agricultural businesses generally still traditional and completely dependent on nature.

For this reason, it is necessary to make efforts to increase the production of peppers by managing environmental conditions such as regulating planting distances and applying fertilizers to plants to be more suitable for the growth of peppers.

The Noongan area is a potential area for the growth of peppers, with an altitude of approximately 700 m above sea level, with rainfall of around 600 – 125 mm per year (BPS, 2019), temperatures ranging from 21 ° C to 27 ° C, moderate to high air humidity in accordance with the growth and production of peppers.

Plant density is a factor that greatly affects the absorption rate of sunlight and nutrients. Plant density can be viewed from several things, namely: the number of leaves (area and arrangement), and planting distances that are directly related to the number of plants. Harjadi (1998), stated that basically regulating plant density is an effort to provide the possibility of plants growing well without experiencing much competition with weeds in nutrient absorption and irradiation of sunlight which further affects plant growth and yield.

Nitrogen (N) is needed by plants in relatively greater quantities compared to plant needs in other nutrients. N deficiency is more often a limiting factor than other elemental deficiencies in plant growth. According to Foth (2000) plant density and root absorption greatly affect the absorption of N in fertilizing; usually N is applied in the form of Urea fertilizer (CH 4 N_2O), ammonium nitrate (NH_4 NO 3) and nitrate fertilizer (NO_3)). The objectives of this study are: 1. To determine the best level of plant density on plant growth and yield. 2. Knowing the effect of the interaction between plant density and nitrogen fertilizer on the growth and yield of paprika plants.

RESEARCH MATERIALS AND METHODS

This research has been conducted for 5 months, namely Apri 2020 - August 2020 in Noongan, West Langoan District, Minahasa Regency, and North Sulawesi Province. The research land is at an altitude of 600 m above sea level, with a temperature of 24 – 26 0 C. Materials used during the study were red pepper seeds, soil, compost, nitrogen fertilizer (Urea). The tools used in this study were 9 kg polybags, meters, stationery, scissors, cameras, analytical scales, and sieves. The materials used during the study were red pepper seeds, soil, compost, urea fertilizer (N) and water.

The study using a Randomized Group Design was repeated 3 times so that 48 experiments were obtained. The treatment plots of this study are: N0: No nitrogen fertilizer (urea), N1: Nitrogen fertilizer 50 kg/ha, N2: Nitrogen fertilizer 100 kg/ha, N3: Nitrogen fertilizer 150 kg/ha and K1: 20 x 20 Cm, K2: 30 x 30 cm, K3: 40 x 40 cm, K4: 50 x 50 cm . If there is a real different influence on the treatment, it is continued by using the BNT (Smallest Real Difference) test with a level of 5%. Observations made include: Plant height, number of leaves, weight of fresh fruit per plant and per hectare.

Table 1. Treatment Arrangement

Treatment	K1	K2	K3	K4
N0	N0K1	N0K2	N0K3	N0K4
N1	N1K1	N1K2	N1K3	N1K4
N2	N2K1	N2K2	N2K3	N2K4
N3	N3K1	N3K2	N3K3	N3K4

RESULTS AND DISCUSSION

Based on the results of the study, it is known that plant height shows interactions between nitrogen fertilizer application treatments and planting distances (Table 2). The parameters of plant height with the application of nitrogen fertilizers and spacing differed markedly at observations of 30 hst and 45 hst, but non-fertilized treatments gave lower yields on all treatments. The application of 100 and 150 kg of fertilizer / has a noticeable effect compared to other treatments. Nitrogen fertilizers are an important nutrient for plants. Nitrogen plays a role in the formation of chlorophyll, where chlorophyll plays a role in the process of photosynthesis (Hokmalipur and Darbandi, 2011).

Plant Height

Table 2. The average height of paprika plants (Cm) due to nitrogen fertilizer treatment and planting distances at various plant ages.

Treatment	Plant Age Days After Planting (HST)		
	15 HST	30 HST	45 HST
N0K1	16.74 ab	28.36 a	38.18 a
N0K2	4.13 pm a	30.10 b	40.22 b
N0K3	4:09 p.m.	29.82 b	41.06 b
N0K4	4.15 pm a	28.96 b	47.36 c
N1K1	24.16 c	46.55 c	49.60 c
N1K2	26.20 d	45.76 c	51.61 d
N1K3	30.43 e	46.70 c	48.87 cd
N1K4	31.78 e	46.59 c	50.65 s
N2K1	34.70 d	49.15 d	62.65 e
N2K2	36.45 f	48.79 s	67.48 f
N2K3	37.45 f	49.83 s	68.15 f
N2K4	36.82 f	50.56 cd	71.62 fg
N3K1	31.78 e	63.70 e	72.43 g
N3K2	35.67 f	71.15 f	80.16 h
N3K3	40.70 g	71.64 f	82.26 h
N3K4	41.48 g	70.86 f	80.86 h
BNT 5%	**9.48**	**12.42**	**14.63**

Description: Numbers followed by unequal letters show a real difference according to the Test The real difference (BNT) at the level of 5% (lowercase)

The highest plants are found in the application of Nitrogen fertilizer 150 kg / ha and at a planting distance of 40 x 40 cm (N3K3) but do not differ markedly from the treatment of N3K2 and N3K4. The lowest tanaman height is pad a treatment without nitrogen fertilizer (control). From the results obtained that the planting distance has a very noticeable effect on the height of the plant. The role of spacing in plant growth is to maintain competition in the fight for food (nutrients) needed by each individual plant. So that to get optimal growth and results, it must meet the basic concept of planting in accordance with SOPs (Standard Operating Procedures). Planting distances are tried regularly so that plants get a uniform growing space, and in maintenance it is easier and easier to carry out weeding spacing arrangements according to the variety planted. The increase in plant height occurs through the increase of segments due to the enlargement of cells as the plant ages. This is in accordance with Agustina's research (2011) that the results of the study stated that planting distance affects plant height in Zucchini plants.

Increased nitrogen dose increases N uptake efficiency (Cerny *et al*. 2012). Maruapey (2010) states that more growth factors are identified by plants including fertilization causing the rate of photosynthesis to increase. The increasing rate of photosynthesis results in more CO 2 being bound in the photosynthesis process than the CO_2 released in the respiration process so that assimilate which produces more (Salisbury and Ross, 1995), and ultimately promotes vegetative growth such as increasing plant height growth.

Number of Leaves Planted

Planting of paprika plants at various levels of nitrogen fertilizers with differences in planting distances has a noticeable effect on increasing the number of leaves of paprika plants, the average number of leaves at all ages of plants is presented on Table 3.

Based on Table 3 it can be seen that the increase in the amount of nitrogen at the same planting distance the number of leaves differs markedly at all ages of plants. The highest number of leaves was found in the N1K4, N2K 4, N3K1 treatments but N3K1 did not differ markedly from the N3K3 and N3K4 treatments. The lowest number of leaves is found in the treatment of not applied nitrogen fertilizer (control). Element N is an element that many plants need, so it requires a sufficient amount of urea fertilizer to produce good growth and yields. The availability of nitrogen in the soil and the regulation of spacing are important factors for plants. The process of photosynthesis will not run effectively if the N element is not available in sufficient quantities. According to Bukman and Brady (1982), the element N is a prominent effect on plants because N tends to promote plant growth and give green color to leaves and increase protein content.

Table 3. The average leaf yield of paprika plants due to nitrogen fertilizer treatment and planting distances at various plant ages.

Treatment	Plant Age Days After Planting (HST)		
	15 HST	30 HST	45 HST
N0K1	9.94 a	3:17 p.m.	30.15 b
N0K2	10.15 a	8.00 pm	5:45 p.m.
N0K3	2.20pm	21.72 b	34.18 c
N0K4	15.46 c	26.60 c	45.68 f
N1K1	16.70 c	28.18 d	41.18 d
N1K2	18.16 s	30.40 de	43.16 e
N1K3	8.14 pm	32.17 EF	43.72 e
N1K4	20.16 e	34.60 g	46.60 f
N2K1	8.78 pm	36.16 h	50.18 g
N2K2	9.60 pm e	36.76 h	42.18 d
N2K3	24.36 f	6:40 pm	46.29 f
N2K4	24.70 f	38.88 i	46.75 f
N3K1	30.46 g	40.76 h	56.17 g
N3K2	35.76 h	41.16 h	52.76 g
N3K3	37:40 i	47.58 K	55.14 g
N3K4	42.36 h	48.12 K	55.78 g
BNT 5%	**5.47**	**9.47**	**13.63**

Description: Numbers followed by unequal letters show a real difference according to the Test The real difference (BNT) at the level of 5% (lowercase)

From the results obtained that the row spacing has a very noticeable effect on the number of leaves. The leaves that have the highest number will cause the photosynthesis process to go well. With the increase in the number of leaves formed, the photosynthesis process will run well and the resulting photosynthetic will be higher, the growth will be better. From the results obtained the number of leaves that have a very noticeable effect is due to the difference in planting distance. Planting distance is a pattern of spacing plants in farming which includes the distance between rows and rows (Rezer, 2010). A good planting distance will facilitate other cultivation actions, the level and type of technology used that can be determined by the type of plant. The function of spacing is to lower the level of competition of one plant with another to get optimal sunlight so that photosynthesis in the plant is not hampered by other plants, to increase the root zone of a plant. This causes the plant to be able to grow well.

Fresh Weight of Planting Fruits and Perhektar

The results showed that nitrogen fertilizers and planting distances and the interaction between the two had a significant effect on weight per sample (g). Table 4. The average bis tight fresh fruit per plant (g) and perhektar (ton) Due to aapplication of nitrogen fertilizer and perbedaan jarak tanam.

Table 4. The average fresh weight (g) and weight per hectare of paprika plants due to nitrogen fertilizer treatment and planting distance.

Treatment	Fresh Weight of Planting (g)	Fresh Weight Perhektar (tons)
N0K1	300.80 A	2.14 a
N0K2	344.62 b	2.82 b
N0K3	345.15 b	2.83 b
N0K4	340.65 ab	2.80 b
N1K1	380.76 c	2.96 BC
N1K2	381.54 c	2.95 BC
N1K3	396.42 cd	2.98 BC
N1K4	389.60 cd	2.94 BC
N2K1	386.70 cd	2.76 b
N2K2	401.26 d	2.70 b
N2K3	416.76 d	3.40 d
N2K4	428.68 e	3.60 s
N3K1	460.65 f	3.94 e
N3K2	478.16 g	4.20 f
N3K3	480.65 h	4. 26 f
N3K4	480.25 g	4.18 f
BNT	**29.65**	**0.76**

Description: Numbers followed by unequal letters show a real difference according to the Test The real difference (BNT) at the level of 5% (lowercase)

The results of the analysis showed that nitrogen fertilizers and planting distances and the interaction between the two had a significant effect on the fresh weight (g) of planting and perhektar. Average weight of planted peppers (g) Due to the application of organic fertilizers and differences in planting distances is presented in Table 4.

The results showed that the N3 (urea fertilizer) treatment gave the highest yield at all planting distances, and the lowest was found in the N0 treatment (without organic fertilizer/control). Urea fertilizer increases the availability of nutrients, especially N elements for plants and reduces the loss of N. Higher N increases vegetative growth and plant yield because element N improves the metabolic processes of proteins and carbohydrates (See *et al*, 2010).

Conclusion

The planting distance suitable for plant growth such as plant height and number of leaves and yield of paprika fruit is at a plant distance of 40 X 40 cm with urea fertilizer of 150 kg / ha. Likewise, the fresh weight of planting and perhektar is found in the same treatment, namely the N3K3 treatment (urea fertilizer 150 kh / ha and planting distance 40 X 40 cm) which gives the highest yield.

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