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Study of NPK Fertilizer Effect on Sunflower Growth and Yield

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Abstract. Sunflower is an introductory plant and quite popular in Indonesia. Until now information about sunflower cultivation and fertilization, especially in the fields are still limited in Indonesia. In this regard, to determine the effect of NPK fertilization on the growth and grain yield of this plant, a study was done in the Experimental Garden of the Assessment Institute for Agricultural Technology East Java (550 m above sea level), from November 2013 to March 2014. The experiment used a randomized block design and repeated four times. As treatments were the N-P-K fertilizer levels (kg ha-1), i.e., 120-50-50, b. 120-75-50, c. 120-50-75-, d. 120-75-75, e. 150-50-50, f. 150-75-50, g. 150-50-75, h. 150-75-75. The result showed that the plant growth affected by NPK fertilizer level. The highest plant posture found on g treatment reaches 132.50 cm, and stem diameter reaches 3.23 cm. Generally, the best harvest yield components such as the flower diameter, flower weight, weight and number of grains, the weight of 100 grains, the weight of 100 seeds were gained from f treatment. The highest grain yield was also obtained at this treatment reaching 2.74 t/ha

INTRODUCTION

Sunflower is an introductory plant and quite popular in Indonesia. Although it has good prospects as an industrial plant, this plant is cultivated and sold as an ornamental plant on a small scale of farming. The needs for grain and sunflower oil in Indonesia are huge. Until now, all domestic needs are still imported from the United States, Australia, and China. Indonesian's import of sunflower grain in 2015 about 11,755,730 tons with price US $ 11,989,569. In addition, imports were also made in the form of oil, reaching 5,440,764 tons with price US $ 6,900,531 [1]. Thus the opportunity to cultivate this plant as a commercial agribusiness is still open widely.

Sunflowers have a broad adaptation environment and require full sunlight areas, but in its growth are not influenced by photoperiodism. Optimal sunflower growth is achieved at temperatures above 10 ^{o}C with altitude from medium to high [2]. In Indonesia, this plant can grow at an altitude up to 1000 m above sea level with rainfall ranging from 50-80 mm/month [3]. But, until now information and publication of sunflower cultivation and fertilization in Indonesia, especially in the fields are still limited.

Inorganic fertilizer components such as N, P and K are essential nutrients for plant growth and the yield. Balanced fertilization of each played a significant role in supplying the nutrients needed, to attain maximum sunflower growth [4]. The level of NPK fertilizer affected the plant growth, and the grain yield of sunflower [5] and maximum grain resulted from 120-90-60 kg ha^{-1} of NPK application [6]. Another study in the field showed that the optimum grain yield was obtained in 90-60-60 kg ha^{-1} of NPK fertilizer [7]. The amount of nitrogen and potassium had a significant effect on plant height, biological yield, seed yield and seed oil content [8]. Nitrogen and phosphorus application also enhanced growth and yield. If N fertilizer applied at the rate of 60 kg ha^{-1} would produce the highest seed and oil yield [9]. A significant increase in crop growth, biomass, dry matter production, and biological yield resulted in 100 kg/ha of N rate application [10]. The study was aimed to find out of the effect of different levels of N, P and K fertilizers on the growth and grain yield of sunflower under the rainfed farming condition.

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EXPERIMENTAL DETAILS

The experiment was carried out in the Karangploso Experimental Garden of the Assessment Institute for Agricultural Technology East Java (550 m above sea level), from November 2013 until February 2014. Soil analysis showed that the land used had pH 6.5, C-organic 1.66%, C/N ratio 9.77, N-total 0.17 %, P-Olsen 44 ppm and K 0.47 me.100 g^{-1}.

The experiment was arranged in a randomized block design with 4 replications. As treatments were the N-P-K fertilizer (kg ha^{-1}) levels, consists of a. 120-50-50, b. 120-75-50, c. 120-50-75, d.120-75-75, e.150-50-50, f.150-75-50, g. 150-75-50 and h.150-75-75. Urea was used as a source of N; SP36 as P and KCl as K in the trial. A full dose of P and K and half dose of N were applied at the time of planting and the remaining half dose of N at the bud initiation stage. The soil was processed and smoothed with the hoe. After that, the beds were made with the 1 m × 2 m size. Then a planting hole was created with digger in the 80 cm × 50 cm spacing. The seeds that have been sown 20 days before were put into the planting hole and covered with manure at a 1000 kg ha-1 dose.

The variables observed were plant height, stem diameter, number of leaves, 80% days to flowering and days to maturity, head diameter, disc weight, the weight of grain per disc, the weight of 100 grain, weight of 100 seeds (the content of the grain), and grain yields. Analysis of variance (ANOVA) was calculated statistically as described by Gomez & Gomez [11]. For statistical analysis, DSAASTAT software was used [12]. Duncan's MRT test was employed upon obtaining significance differences among means [13].

RESULT AND DISCUSSION

Plant Growth

Generally, plant growth was affected significantly by NPK levels. Although in the first and second observation, the plant height was not influenced by NPK treatment. The significant effect of NPK to plant height was obtained in the last observation, after the early generative stage of the plant. The highest plant obtained from f treatment (150-75-50 kg ha^{-1}). Another researcher cited the same result that plant height significantly increased with an increase in NPK levels [14]

The stem diameter was affected considerably by NPK levels. The biggest stem was gained from d treatment (120-75-75 NPK levels). The other observation showed that the total leaves were also significantly affected by NPK levels. The most number of leaves obtained from treatment h (150-75-75 kg ha^{-1} NPK. The same result also reported by Bakht *et al.* [14].

TABLE 1. Effect of NPK levels to plant growth of sunflower

Treatments (N-P-K (kg ha^{-1})	Plant height (cm)			Stem diameter (cm)	Number of leaves/plant	Days to flower	Days to maturity
	30 DAP	45 DAP	60 DAP				
120-50-50	49.68 a	76.83 a	114.84 c	2.26 c	16.35 bc	57.88 b	117.88 b
120-75-50	51.32 a	77.66 a	119.8 bc	2.61 b	17.50 ab	61.0 ab	121.17 ab
120-50-75	43.34 ab	79.10 a	121.68 bc	2.73 b	15.43 c	60.4 ab	120.35 ab
120-75-75	37.82 b	72.35 a	119.66 bc	3.25 a	16.16 bc	61.0 ab	121.50 ab
150-50-50	39.67 b	78.62 a	122.00 bc	3.10 a	16.62 bc	63.84 a	121.66 ab
150-75-50	46.18 ab	79.67 a	123.72 bc	3.23 a	16.65 bc	61.18 ab	123.16 a
150-50-75	47.00 ab	83.23 a	132.50 a	3.07 a	17.50 a	61.00 ab	121.17 ab
150-75-75	47.35 ab	81.87 a	125.17 ab	3.21 a	18.77 a	62.83 a	122.87 a
CV	16.71	13.93	5.86	7.76	8.32	4.48	2.46
SE	4.09	4.30	2.93	0.09	0.57	1.12	1.12

On the other hand, the days to flowering also significantly affected by NPK level. The fastest to plant flowering gained from a treatment (120-50-50 kg ha^{-1} NPK). The same occurrence also found in the days to maturity and significantly influenced by NPK levels. The fastest of plant maturity obtained at a treatment (120-50-50 kg ha^{-1} NPK). A similar finding was reported that the different NPK level was significantly affected the days to flowering. Increasing NPK dose level was also increased the number of days to flowering because increasing NPK dose would accelerate vegetative growth, which responsible for their delay in flowering [15]. Another study showed that the increase of NPK levels significantly increased of disc diameter (13%), plant height (4%) and days to maturity (8%) [16].

Harvest Yield

The effect of NPK fertilizer levels on the harvest yield components showed in Table 2. NPK level significantly affected the diameter and dry weight of the head. The biggest diameter of the head was obtained in treatment f, g and h. The heaviest dry weight of the head was also found in all three treatments. This occurrence indicates that N fertilization with a dose of 150 kg ha^{-1} plus P and K can increase the size of the diameter and the dry weight of the flower disc. Vice versa, Bakht *et al*. reported the different result that the head diameter was none significantly increased by fertilizer treatments of 100:100:50 kg ha^{-1} of NPK compared with the other treatments [14].

Observation of the grain number and grain weight per flower disc showed a significant difference between the levels of NPK fertilizer tested (Table 2). The highest number of grain obtained in h treatment reached 1,298.57. The highest grain weight per disc gained in the f and h treatment i.e. 76.15 g and 76.60 g. The same result was reported that NPK levels significantly affected the number of grains per disc [15]. The number of grain per disc increased with increasing NPK levels. Maximum grain yield was produced by fertilizer treatments of 150:100:100 kg ha^{-1} [16]

TABLE 2. Effect of NPK levels to yield component

Treatments (N-P-K) (kg ha^{-1})	Head diameter (cm)	Dry head weight (g)	Total grain/disk	Grain weight/ disk (g)	100 grains weight (g)	100 seeds weight (g)	% 100 seeds
120-50-50	16.68 c	242.80 d	734.87 c	52.39 c	5.70 d	3.89 d	76.73 b
120-75-50	19.50 bc	273.24 cd	872.00 bc	60.54 bc	5.85 bcd	4.86 c	83.23 ab
120-50-75	19.75 bc	268.54 cd	821.79 bc	57.39 c	5.34 d	4.42 cd	85.17 a
120-75-75	18.41 c	289.58 bcd	847.84 bc	63.76 abc	5.86 bcd	4.78 cd	81.57 ab
150-50-50	18.08 c	293.29 bc	910.52 b	68.45 abc	5.58 cd	4.53 cd	82.70 ab
150-75-50	23.42 a	347.49 a	949.88 b	76.15 a	7.24 a	6.03 a	82.88 ab
150-50-75	21.65 ab	321.50 ab	842.81 bc	65.16 abc	6.58 abc	5.14 bc	78.03 ab
150-75-75	23.68 a	352.93 a	1,298.57 a	76.60 a	6.96 ab	5.80 ab	83.64 ab
CV	11.61	11.80	12.04	1,8	15,52	14.36	6.68
SE	0.95	14.38	4.41	4,91	0,41	0.29	2.22

Furthermore, observations on the weight of 100 grains and 100 seeds showed a significant difference between the levels of NPK fertilizer tested (Table 2). The highest weight of 100 grains was obtained at f treatment, and the lowest weight at a treatment. The highest weight of 100 seeds was obtained at d, f, and h treatment. The NPK dosage treatment levels also had a significant effect on the percentage of 100 seeds. The highest rendering obtained in treatment c reached 85.17%. This result was parallel to another study that the response of 1,000 grain weight to NPK levels was significant [15]

TABLE 3. Effect of NPK levels to component grain yield

Treatments (N-P-K) (kg ha^{-1})	Grain yield/plot (g/2 m^2)	Grain yield (t/ha)
120-50-50	355.62 c	1.778 c
120-75-50	419.93 bc	2.095 bc
120-50-75	404.77 bc	2.024 bc
120-75-75	484.39 abc	2.444 abc
150-50-50	461.93 abc	2.310 abc
150-75-50	547.64 a	2.744 a
150-50-75	488.85 ab	2.444 abc
150-75-75	510.03 ab	2.550 ab
CV	10.98	10.98
SE	39.98	1.96

Observations of the yield showed a significant difference in grain yield per plot and grain yield ha^{-1} (Table 3). The highest grain yield per plot was obtained at f treatment reaching 547.64 g and the lowest grain yield obtained in treatment about 355.62 g. The highest grain yield obtained in f treatment that reached 2.74 t/ha and it was not significantly different with d, e, g and h treatment. A similar occurrence reported that the sunflower grain yield was significantly affected by the different NPK levels [15]. Application of NPK in the high level gave more grain yield and oil [4,6]. Another study showed that maximum seed yield was produced by fertilizer combinations of 150: 100: 100 kg ha^{-1} NPK [14]. Another report also showed that the increasing NPK levels were significantly increased the 1,000 grain weight, biological yield, and grain yield [17]. NPK uptake by the plants may be influenced by soil nutrients, availability of nutrients and growing conditions [18].

SUMMARY

Plant growth and yield of sunflower seeds were influenced by NPK fertilizer. In general, the best growth of the plant and the highest harvest yield were obtained from NPK treatment 150-75-50 kg ha^{-1}. The application of NPK fertilizer at this level obtained the highest grain yield about 2.74 t/ha. This level of NPK fertilizer can be recommended for the cultivation of sunflowers on dry land during the rainy season.

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