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Araştırma Makalesi / Research Article

The Effect of Inorganic Nitrogen and Phosphorus Fertilizers, Chicken Manure and Their Combinations on Growth and Development of Common Bean (*Phaseolus vulgaris* L.)

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Abstract

Common bean is one of the most widely grown of grain legumes, being cultivated from the tropics to temperate regions. The present study was aimed to determine the effect of chicken manure doses, nitrogen and phosphorus fertilizers on growth of common bean. The experiment was conducted from March to July 2020 in the Dicle University, Agriculture Faculty, Field Crops Department Experiment Farm. The treatments composed of control, 40N+80P kg ha^{-1}, Chicken (C) 2000 kg ha^{-1}, Chicken (C) 2000+40N+80P kg ha^{-1}, Chicken (C) 3000 kg ha^{-1} and Chicken (C) 3000+40N+80P kg ha^{-1}. Treatment was arranged in a randomized complete block design with three replications. The effect of chicken manure and nitrogen and phosphorus combinations on the plant traits is higher than the treatments alone. The differences among treatments for compared crop growth rates (CGR), net assimilation rate (NAR), leaf area index (LAI), leaf area duration (LAD) and specific leaf area (SLA) were significant, and the highest CGR, NAR, LAI values were in Chicken 3000+40N+80P kg ha^{-1}. NAR of Chicken 3000 kg ha^{-1} and Chicken 3000+40N+80P kg ha^{-1} treatments were significantly lesser than those of the other treatments included control.

Keywords: Net assimilation rate, leaf area index, leaf area duration, organic fertilizer

INTRODUCTION

Legumes are an excellent source of good quality protein with 20–45% protein that is generally rich in the essential amino acid lysine (Philips, 1993). The high protein content of legumes can be attributed to their association with the activity of the nitrogen-fixing bacteria in their roots, which converts the unusable nitrogen gas into ammonium which the plant then incorporates into protein synthesis (Maphosa and Jideani, 2017). Common bean (Phaseolus vulgaris L.) is a major grain legume which is consumed worldwide for its edible seeds and pods (Heuzé et al., 2013). It is one of the most widely grown of grain legumes, being cultivated from the tropics to temperate regions (Acosta et al., 2007). China, Iran, Turkey and Japan are the most important countries that produce common bean in Asia. It arrived in Turkey in the 17th century. Despite its foreign origin, common bean is an agricultural crop cultivated for fresh pods and for dry seed all over Turkey, and is regarded as a national food (Bozooglu and Sozen, 2007). Common beans, like all other legumes, can fix atmospheric dinitrogen [N2] through symbiotic association with rhizobium bacteria in the soil and hence reduce the dependence on inorganic nitrogen (N) fertilizers (Tagoe et al., 2010). However, N2 fixation alone could be to be insufficient to support maximum yield in the field like our country soils in common bean. There are various reasons for this, including cultivar, geographic area of crop, high temperature, drought, soil, constrain legume root-nodule formation and function (Hungria and Vargas, 2000; Liu et al., 2011). Moreover, Phaseolus vulgaris cultivars, especially bush cultivars, which are short-lived annuals and may not have a sufficiently long vegetative phase to fix enough N2 before reproductive growth (Sprent, 1982). The efficiency of the nitrogen fixing activity of the symbiotic association between bacteria and plants varies among legume species, and common bean is often characterized as poor nitrogen fixer (Isoi and Yoshida, 1991), some additional N provided through fertilizer usually is required for a maximum yield and nodulation (Mitiku, 1990). Phosphorus supplementation is also important to ensure maximum yield and nodulation efficiency as well as nitrogen. Moreover, it has been proposed that P deficiency may reduce crop growth by inhibiting leaf expansion and photosynthesis (Lynch et al., 1991). Common bean is often grown in soils of low P availability. Phosphorus (P) fertilizer efficiency in agricultural systems is low, with only 10–20% of fertilizer applied P used by crops in the year of application, and residual value rarely exceeding 50% (Bolland and Gilkes, 1998). The effect of organic fertilizers on the growth and development of dry beans is undeniable as much as inorganic nitrogen and phosphorus fertilizers. All or most of organic fertilizer comes from nature. Animal waste, crop residues, household waste, and stones are the basic ingredients of organic fertilizer (Sitinjak and Purba, 2018). Organic fertilizers may be the best substitute for chemical fertilizers. However, there are positive interaction between the combination of organic and mineral fertilizers (Bodruzzaman et al., 2010; Ucar, 2019). Many studies have been reported on the effects of the use of chicken manures and inorganic fertilizers on many grain legumes. Chicken manure is efficient in terms of total nitrogen as fertilizer and had appreciable residual effect, and grain yield, grain quality and straw yield were promoted by rate of chicken manure (Tagoe et al., 2010; Sitinjak and Purba, 2018; Ucar and Erman, 2020). It is an accepted fact that inorganic fertilizers in agricultural production significantly increase the growth and development of plants. However, it is very difficult to compensate for the damage these fertilizers cause to the soil, the environment and the living ecosystem. Although organic fertilizers can not contribute to the yield as much as inorganic fertilizers, since they improve the physical, chemical and biological properties of the soil, it is very important for the sustainability of agricultural production to be given with chemical fertilizers or in single form. The present study was aimed to determine the effect of chicken manure doses and nitrogen and phosphorus fertilizers on growth of common bean.

MATERIAL and METHODS

The experiment was conducted from March to July 2020 in the Dicle University, Agriculture Faculty, Field Crops Department Experiment Farm. The soil is light-alkaline (pH 7.46), cracking clay with about 50% clay content. It contains about 0,640% organic matter, 0.032% nitrogen (N), 13.6 kg ha^{-1} potassium (K) and 0.188 6 kg ha^{-1} available phosphorous (P). The meteorological data during the crop period indicated that the total amount of rainfall received during crop season was 55.2 mm only in May, not received any rainfall June to August. Mean daily maximum air temperatures were ranged from 25.1 in April to 42.6 °C in July. Minimum air temperatures were recorded 2.2 °C in April and 17.0 °C in July. The treatments composed of control, 40N + 80P kg ha^{-1}, Chicken (C) 2000 kg ha^{-1}, Chicken (C) 2000 + 40N + 80P kg ha^{-1}, Chicken (C) 3000 kg ha^{-1} and Chicken (C) 3000 + 40N + 80P. The chicken manure was obtained from poultry farm in livestock Department. The chicken manure and N and P fertilizers were applied by hand-mixing the manure thoroughly with the top 5–10 cm soil the side rows. The treatments were applied on 27th April 2020, and soil was well irrigated after manure application to allow decomposition of the manure and for the soil to settle. Seeds of common bean cultivar, Aras 98, had an indeterminate bush-like growth habit (Type II) were sown on 21st April 2020 at a rate of 222 ha^{-1}. Treatment was arranged in a randomized complete block design with three replications. The plot size was 4 m length, and 5 rows, having row to row distance of 45 cm. The crop was irrigated at field capacity to avoid any potential water deficit impact on crop yield. The full emergence and first blooming dates for all plots were in 2nd May and 6th June 2020, respectively. Plant samples harvested and every 20 d after 20 DAE. Shoots were harvested as well roots in each plot. The harvested shoots were separated into leaves, stems, flowers and pods, and weighted as fresh. The roots were washed to clean of soil. The leaves were used to estimate the total leaf area. After oven-drying harvested samples at 80 °C for 72 hours. The dried samples were weighed to determine the dry weights of roots, leaves and stems and the total dry matter weight. Color analysis was measured in three repetitions using Hunter Lab D25LT. Crop growth rate (CGR): Crop growth rate is the gain in dry matter production on a unit of land in a unit of time. CGR= W_2-W_1 / t_2-t_1 (g m^{-2} day^{-1}). Net assimilation rate (NAR): Net assimilation rate (NAR) or unit leaf rate is the net gain of assimilate per unit of leaf area and time. NAR= (W_2−W_1) (log$e$$LA_2$ -log$e$$LA_1$) / ($t_2$-$t_1$) ($LA_2$− LA_1) (g m^{-2} day^{-1}). Leaf area index (LAI):- Leaf area index (LAI) is the ratio of leaf area to the area of ground cover. It is the leaf area (one surface only) divided by the land occupied by the plants. LAI= LA/GA. Leaf area duration (LAD): Leaf area duration (LAD) expresses the magnitude and persistence of leaf area or leafiness during the period of crop growth. LAD = (LA_2− LA_1) / $(t_2\text{-}t_1)^2$. Leaf area ratio (LAR): Leaf area ratio (LAR) is the ratio of the total leaf area to the whole plant dry weight and is a further measure of the efficiency of leaf surface in producing dry matter. LAR = (LA_1 / W_1) + (LA_2 / W_2) / 2 (m^2 g^{-1}). Specific leaf area (SLA): Specific leaf area is the ratio of leaf area (cm^{-2}) $plant^{-1}$ to leaf dry weight (g). Leaf weight ratio (LWR): Leaf weight ratio is the ratio of total leaf weight (g) to total plant weight (g). W_1 = dry weight per unit area at t1, W_2 = dry weight per unit area at t_2, t_1 = first sampling, t_1 = second sampling. LA_1 = leaf area at t_1, LA_2 = leaf area at t_2. LA= Leaf area, GA=Ground area Agrawal (4). The analysis of variance was performed to detect the difference among treatments by ANOVA. The significance of mean values was analyzed using LSD test (0.05) except.

RESULTS and DISCUSSION

Crop growth rate is affected by a range of factors including temperature, levels of solar radiation, water and nutrient supply, crop, cultivar and its age. These factors influence the size and efficiency of leaf canopy and hence the ability of crop to convert solar energy into economic growth. To identify the factors responsible for differences in dry matter accumulation, it was compared crop growth rates (CGR) and the photosynthetic components until maturity among treatments. The differences among treatments for compared crop growth rates (CGR), net assimilation rate (NAR), leaf area index (LAI), leaf area duration (LAD) and specific leaf area (SLA) were significant, but differences among treatments for leaf area rate (LAR) and leaf weight rate (LWR) were no significant (Table 1).

Table 1. Effect of chicken manure and NP fertilizer doses on growth parameters of common bean at DAE (days to after emergence) 20, 40, 60, and 80.

Treatments	CGR ($g/cm^{-2}\ day^{-1}$)	NAR ($g/m^{-2}\ day^{-1}$)	LAI (cm^2)	LAR ($cm^2\ g^{-1}$)	LAD	LWR	SLA
Control	35.3 e	0.115 ab	0.31 d	17.5	8709.3 d	0.086	202.1 ab
40N+80P	49.8 c	0.118 ab	0.42 cd	17.2	11704.8 c	0.088	193.5 b
Chicken2000	47.5 c	0.120 ab	0.60 b	18.2	11759.5 c	0.096	193.3 b
Chicken2000+ 40N+80P	60.9 b	0.130 a	0.49 bc	16.2	13580.3 b	0.079	205.3 a
Chicken3000	40.4 d	0.068 c	0.43 cd	18.3	12460.0 bc	0.093	195.8 ab
Chicken3000+ 40N+80P	72.5 a	0.080 bc	0.84 a	16.2	19679.3 a	0.096	182.0 c
LSD	1.75	0.02**	0.045*	ns	837.139	ns	5.26**
DAE 20	17.4 d	0.15	0.40 cd	20.1 a	5115.7 d	0.102 a	210.2
DAE 40	39.0 c	0.13	0.30 d	21.3 a	12051.5 c	0.109 a	196.8
DAE 60	76.5 a	0.13	0.63 b	16.9 b	18446.5 a	0.089 a	189.5
DAE 80	71.4 b	0.003	0.79 a	10.7 c	16315.0 b	0.059 b	184.7
DAE 100			0.46 c				
LSD	0.59**	0.02**	0.057**	0.72**	473.39**	0.007*	ns
DAE	P<0.0001	P<0.05	P<0.01	P<0.01	P<0.000	P<0.05	P>0.05
Treatment	P<0.0001	P>0.05	P<0.0001	P>0.05	P<0.0001	P>0.05	P<0.01
DAE x Treatment			P<0.0001				

Means in similar category with different alphabets differ significantly, ns: no significant.

The CGR of Chicken 3000 + 40N + 80P kg ha^{-1} tended to be higher than those of control and the other treatments (Table 1, Fig 1). As the dose increased, the growth increased significantly, but CGR of Chicken 2000 + 40N + 80P kg ha^{-1} was higher than that of Chicken 3000. This increase may assumed to be due to nitrogen and phosphorus application. The differences for the net assimilation rate (NAR) among treatments was significant, but NAR had the opposite effect of CGR over treatments. NAR of Chicken 3000 kg ha^{-1} and Chicken 3000 + 40N + 80P kg ha^{-1} treatments were significantly lesser than those of the other treatments included control (Table 1, Fig 2). The relatively higher mean leaf area index (LAI) and leaf area duration (LAD) might contribute to the higher CGRs in Chicken 3000 + 40N + 80P kg ha^{-1} treatment (Table 1, Fig 3), because of their significantly high leaf area index (LAI) and leaf area duration (LAD) (Table 1). The highest specific leaf area (SLA) among treatments were in Chicken 2000 40N + 80P kg ha^{-1} and then control. Generally the CGR of alone chicken or NP treatments tented to be lesser their combinations.

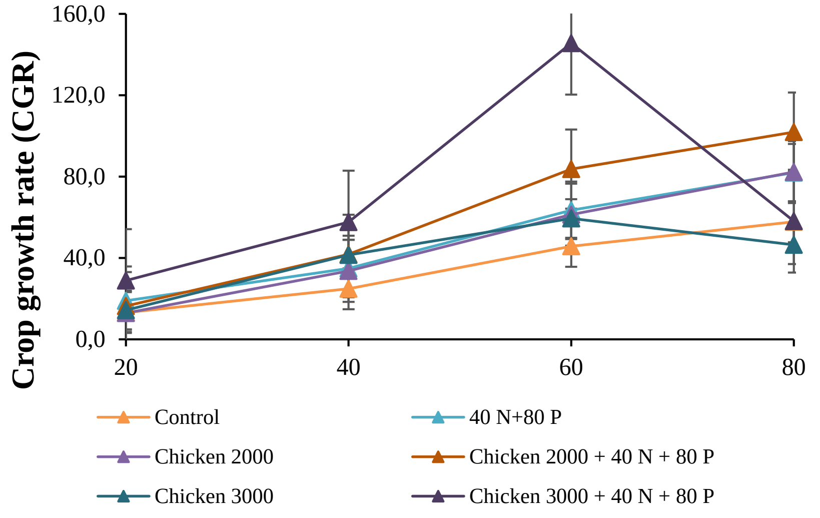

Figure 1. Effect of chicken manure and NP fertilizer doses on crop growth rate of common bean

The highest CGR and LAD during growth season from 20 days to 100 days was in DAE 60, the flowering time. This result revealed that the CGR appear responsible for the greater production of dry matter in DAE 60 and chicken 3000 40N + 80P fertilizer. The highest LAI was in DAE 80, flowering to pod setting time. The leaf area rate (LAR) decreased as the number of days increased from DAE 40 days to DAE 80, as a result of the decrease in the ratio of leaf to stem (Table 1). Crop growth rate is affected by a range of factors including temperature, levels of solar radiation, water and nutrient supply, crop, cultivar and its age. These factors influence the size and efficiency of leaf canopy and hence the ability of crop to convert solar energy into economic growth. NAR, LAR, LWR and SLA decreased from DAE 20 to DAE 80, but the high CGR, LAI and LAD were in DAE 60 (Table 1, Fig 1, 3). The effect of chicken manure and NP fertilizer treatments for plant height, fresh plant biomass, stem fresh weight, leaves fresh weight, fresh and dry pod yield, number of pods per plant and dry plant biomass were significant. The harvest time, also, from DAE 20 to DAE 100, and fertilizer treatment interaction were evaluated (Table 2).

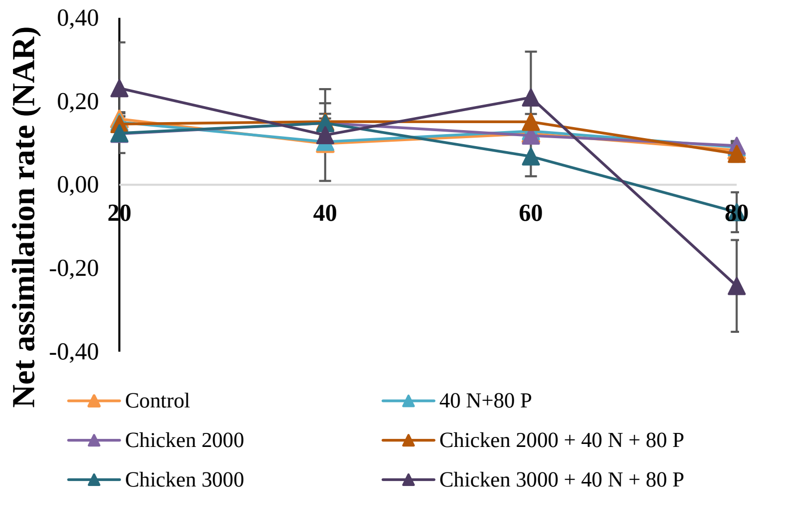

Figure 2. Effect of chicken manure and NP fertilizer doses on net assimilation rate of common bean

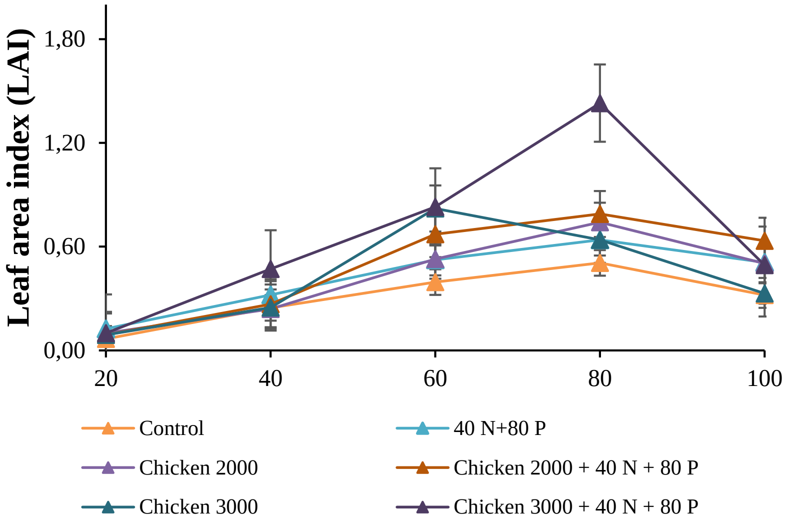

Figure 3. Effect of chicken manure and NP fertilizer doses on leaf area index of common bean

Plant height ranged from 28.2 cm to 39.4 cm, and plant height affected by fertilizer treatments. Chicken 3000 + 40N + 80P kg ha^{-1} and chicken 2000 + 40N + 80P kg ha^{-1} treatments increased the plant height, chicken 2000 treatment decreased. In different harvest times, alone 40N + 80P kg ha^{-1} and its chicken manure combinations also significantly increased plant height. Increased plant height due to NP fertilization (Abebe, 2009; Géant , 2020) and chicken manure supply Ngosong et al., (2020) have been reported in common bean. The addition of humic acid increased plant height, number of leaves, leaf area, leaf area index, dry matter and crop growth rate (Abdulameer and Ahmed, 2019). Fresh plant biomass ranged from 33.6 g plant^{-1} to 77.3 g plant^{-1}, treatments affected the fresh plant biomass, and treatment of chicken 3000 + 40N + 80P kg ha^{-1} significantly increased fresh plant biomass. Treatment of only chicken manure showed low efficiency (Table 2). Stem fresh weight ranged from 12.2 g plant^{-1} in control to 27.2 g plant^{-1} in chicken 3000 + 40N + 80P kg ha^{-1} fertilizer. Leaf fresh weight affected by treatments, and treatment of chicken 3000 + 40N + 80P kg ha^{-1} significantly increased the leaf fresh weight, however control was the lowest, while other treatments were similar to each other. Muneer and Rabee (2017) reported that high level treatment of sewage significantly increase in rates of vegetative characteristics. Differences among treatments for pod fresh and dry yield (from DAE 60 to DAE 100) were significant, but had no significant for number of pods per plant.

Table 2. Effect of chicken manure and NP fertilizer doses on plant parameters of common bean at DAE (days to after emergence) 20, 40, 60, 80 and 100.

Treatments	Plant height (cm)						Fresh plant biomass (g plant^{-1})					
	DAE 20	DAE 40	DAE 60	DAE 80	DAE 100	Mean	DAE 20	DAE 40	DAE 60	DAE 80	DAE 100	Mean
Control	21.7 b	24.7 b	31.3 b	28.7 bc	30.5 bc	30.2 cd	4.2	4.7 d	26.0 c	37.2 e	37.7 c	33.6 d
40N+80P	15.7 c	29.7 a	36.3 ab	41.7 a	36.0 a	38.0 a	6.0	20.5 b	37.0 b	59.1 c	58.5 b	51.6 c
Chicken2000	13.7 c	23.3 bc	28.7 b	24.7 c	31.3 bc	28.2 d	5.7	14.5 c	39.8 b	47.4 d	59.0 b	48.8 c
Chicken2000+ 40N+80P	26.7 a	28.3 a	32.3 b	40.7 a	35.0 ab	36.0 ab	6.0	17.2 bc	46.6 b	70.2 b	72.8 a	63.2 b
Chicken3000	14.3 c	20.0 c	34.0 ab	35.7 ab	28.3 c	32.7 bc	5.5	14.2 c	46.6 b	61.6 bc	34.3 c	47.5 c
Chicken3000+ 40N+80P	24.0 ab	24.8 b	42.0 a	39.0 a	37.3 a	39.4 a	6.6	33.2 a	60.6 a	125.0 a	46.2 bc	77.3 a
LSD 0.05	1.6**	1.54**	3.7**	3.9**	2.08**	1.9**	ns	2.36**	4.3**	4.14**	7.42**	2.82**

	Stem fresh weight (g plant^{-1})						Leaf fresh weight (g plant^{-1})					
	DAE 20	DAE 40	DAE 60	DAE 80	DAE 100	Mean	DAE 20	DAE 40	DAE 60	DAE 80	DAE 100	Mean
Control	1.6	5.6 c	9.9 c	10.0 d	16.8 b	12.2 e	2.6	8.8 c	13.9 c	13.8 c	11.8	13.2 c
40N+80P	2.1	8.8 b	14.8 bc	19.2 b	22.5 a	18.8 bc	3.8	11.7 b	19.1 bc	22.8 b	16.3	19.4 b
Chicken2000	1.8	6.0 c	14.0 bc	17.4 bc	17.6 b	16.3 cd	3.9	8.4 c	23.4 bc	23.9 b	17.3	21.5 b
Chicken2000+ 40N+80P	2.2	7.1 bc	15.4 bc	19.6 b	22.7 a	19.2 b	3.6	9.4 c	21.4 bc	23.1 b	19.2	21.2 b
Chicken3000	2.1	5.5 c	18.0 b	14.9 c	12.0 c	15.0 d	3.1	8.7 c	25.1 ab	22.2 b	12.6	19.9 b
Chicken3000+ 40N+80P	2.4	14.4 a	25.3 a	40.9 a	15.5 bc	27.2 a	4.2	18.8 a	34.2 a	51.9 a	14.4	33.5 a
LSD 0.05	ns	0.96**	2.82**	1.73	1.64**	1.2**	ns	0.93*	4.77**	2.66**	ns	1.98**

	Pod fresh yield (g plant^{-1})				Number of pods per plant				Dry pod yield (g plant^{-1})			
	DAE 60	DAE 80	DAE 100	Mean	DAE 60	DAE 80	DAE 100	Mean	DAE 60	DAE 80	DAE 100	Mean
Control	1.8 bcd	21.0 bc	13.6 c	12.1 c	5.0 a	5.3	4.8 bc	5.1	0.20 bcd	2.4 c	4.1 cd	2.2 c
40N+80P	2.4 bc	16.7 c	19.3 b	12.8 bc	2.3 b	5.0	6.7 ab	4.7	0.30 b	3.6 c	6.7 b	3.5 b
Chicken2000	1.2 cd	10.3 d	23.7 b	11.8 c	1.0 c	5.7	8.3 a	5.0	0.05 cd	2.9 c	8.3 ab	3.8 b
Chicken2000+ 40N+80P	9.6 a	26.8 ab	30.4 a	22.3 a	4.7 a	7.7	9.0 a	7.1	0.87 a	6.2 a	10.2 a	5.7 a
Chicken3000	3.1 b	24.8 b	9.2 c	12.3 bc	2.3 b	6.0	3.7 c	4.0	0.24 bc	4.0 bc	2.8 d	2.4 c
Chicken3000+ 40N+80P	0.5 d	30.9 a	12.8 c	14.7 b	0.6 c	11.7	7.0 ab	6.4	0.03 d	5.6 ab	5.9 bc	3.9 b
LSD 0.05	0.59**	3.99**	2.39**	1.2**	0.55*	ns	1.15*	Ns	0.09**	0.75**	1.11**	0.4*

	Dry plant biomass (g plant^{-1})					
	DAE 20	DAE 40	DAE 60	DAE 80	DAE 100	Mean
Control	0.6	2.7 b	5.1 c	9.3 d	12.0 c	6.0 d
40N+80P	1.0	3.8 ab	7.2 bc	13.0 c	17.0 b	8.4 bc
Chicken2000	0.7	2.6 b	6.9 bc	12.6 c	17.1 b	8.0 cd
Chicken2000+ 40N+80P	1.0	3.3 b	8.5 b	17.2 b	21.2 a	10.2 ab
Chicken3000	0.9	2.9 b	8.4 b	12.3 c	9.9 d	6.9 cd
Chicken3000+ 40N+80P	1.0	5.9 a	11.8 a	29.7 a	13.1 c	12.3 a
LSD 0.05	ns	2.39**	2.43**	3.98**	2.85	1.03**

	Leaf color L*				A				b			
	DAE 40	DAE 60	DAE 80	DAE 100	DAE 40	DAE 60	DAE 80	DAE 100	DAE 40	DAE 60	DAE 80	DAE 100
Control	39.1	41.5	41.2	49.2	-5.6	-5.4	-4.2	-7.0	11.3	11.7	10.0	17.6
40N+80P	44.0	44.1	42.0	45.9	-5.7	-5.3	-4.7	-5.0	14.1	14.9	11.1	13.9
Chicken2000	32.4	41.5	40.6	46.5	-4.6	-6.0	-5.3	-5.4	9.9	12.5	10.6	15.0
Chicken2000+ 40N+80P	40.7	42.6	41.4	46.5	-5.2	-5.9	-4.4	-5.0	12.8	12.8	11.3	13.2
Chicken3000	44.3	40.6	46.8	46.6	-4.8	-5.2	-5.0	-5.6	14.1	11.3	13.6	13.1
Chicken3000+ 40N+80P	38.5	44.1	44.9	46.2	-4.9	-6.4	-4.4	-3.8	10.6	15.3	13.8	13.2

Means in similar category with different alphabets differ significantly, ns: no significant

The highest dry pod yield plant^{-1} was in Chicken 2000 + 40N + 80P kg ha^{-1} treatment compared to control and other treatments. While Chicken 3000 + 40N + 80P kg ha^{-1} fertilization increased the leaf and stem parts, it decreased the pod yield. Some researcher (Choudhari et al., 2001; Kumar et al., 2009) reported the combine application of organic and inorganic fertilizers were significant for growth and development in French bean. The results of Dhary and Al-Baldawi (2017) showed that the application of NPK fertilizer highest number of branches per plant, leaf area, pod numbers per plant and seed number per pod compared to control treatment. Alkurtany et al., (2018) reported bio-fertilizer treatment increase dry vegetative weight, number of pods in the plant and nitrogen concentration in the vegetative portion. It was statistically determined that leaf colors were not affected by fertilizer treatments in all harvest periods. However, at flowering and pod setting times, DAE 60, NP and chicken manure + NP combinations were increased the L* and b* values relatively. At DAE 80, nearly end of pod setting stage the highest values for L* and b* were in Chicken 3000 kg ha^{-1} and Chicken 3000 + 40 N + 80 P kg ha^{-1} treatments. Chicken 2000 kg ha^{-1} and Chicken 3000 kg ha^{-1} treatments for a* values were higher than control and other treatments in the same stage. At DAE 100, the highest l values were under control but decreased in others (Table 2). The dry plant biomass increased as the number of days increased, the highest dry plant biomass occurred on the 80th day and the effect of Chicken 3000 + 40N + 80P kg ha^{-1} application was significant when the stem and leaf weights were taken into account compared to control and other treatments.

It has been determined that the treatment of chicken 3000 kg ha^{-1} without nitrogen and phosphorus fertilizers is as low as other treatments. This difference is much more obvious, especially on the 80th day of growth (Table 2, Fig. 4). Treatments of organic (chicken manure) and inorganic fertilizers (NP) and their combinations influenced the plant height, fresh and dry plant biomass, leaf weight, fresh and dry pod yield. This observation is in agreement with those reported by Tagoe et al., (2010) and El-Yazal (2019) and who observed significant increases in total dry matter yield, pods and seed per plant of common bean in response to chicken manure application. Common bean grows well at temperatures ranging from 15 to 27 °C and will withstand temperatures up to 29.5 °C. High temperature (close to or higher than 35 °C) and moisture stress during flower and pod setting results in abortion of large numbers of blossoms and developing pods. This is why common beans are rarely grown mainly in the in the heat plains of the Southeast Anatolia region in Turkey. In the experiment field, min and max temperatures were 2.2 °C - 25.1 °C in April to 17.0 °C - 42.6 °C in July, respectively. This may account for the poor vegetative and reproductive growth of common bean, especially pod yield, in this study. This observation is in agreement with that reported by Gross and Kigel (1994) in common bean high temperatures during flowering result in shedding of flowers, leading to the formation of fewer pods.

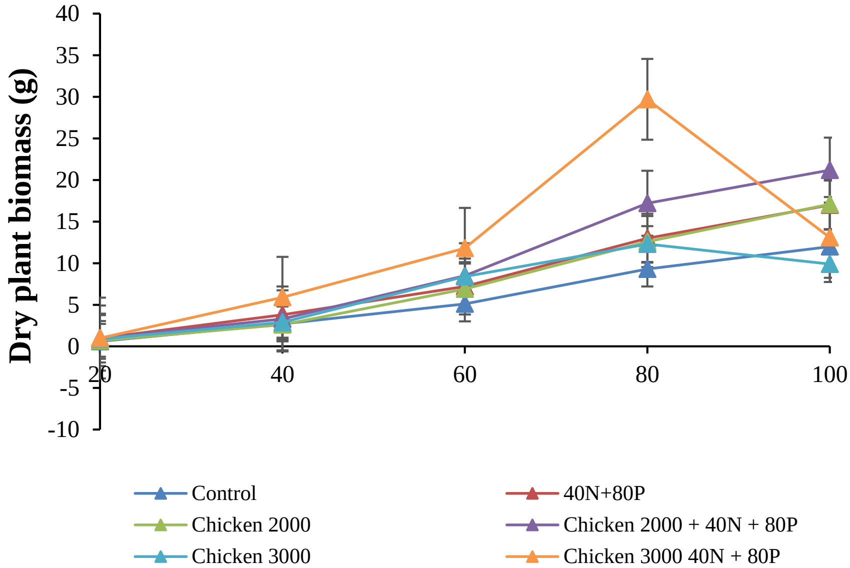

Figure 4. Effect of chicken manure and NP fertilizer doses on dry plant biomass of common bean

CONCLUSIONS

Common bean plants were harvested at 20 days intervals after emergence. Chicken and NP and their combinations increased the growth and development of common bean, and were affected crop growth rates (CGR), net assimilation rate (NAR), leaf area index (LAI), leaf area duration (LAD) and specific leaf area (SLA). CGR, LAI and LAD of Chicken 3000 + 40 N + 80 P treatment were higher than those of control and other treatments.

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