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Effects of Different Doses of Poultry Manure Application on Yield Components and Yield of Different Faba Bean (*Vicia faba* L.) Varieties

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ABSTRACT

Background: A study was conducted to determine the effects of different doses of poultry manure application on the yield and some yield components of faba bean crop under ecological conditions of Siirt province, Southern Eastern Anatolian Region of Turkey.

Methods: The study was carried out in randomized complete block design with 3 replications. The main plots were varieties and the sub-plots were poultry manure doses. At 15 days prior to sowing, 0 (control), 500, 1000, 1500 kg ha^{-1} of poultry manure was spread and mixed with a rake.

Result: All observed parameters were effected from poultry manure doses. Application of 1000 kg/ha poultry manure was found superior in terms of yield and yield related parameters. Grain yield was highest at 1000 kg/ha poultry manure application in 2017 and 2018, (2119 kg/ha and 2083 kg/ha, respectively). Salkım variety was superior in terms of grain yield and most of the other parameters. Both varieties were yielded higher and most of the parameters were higher in 2017 compared to 2018. As a result of the study, cropping "Salkım" faba bean variety with 1000 kg/ha poultry manure application in South Eastern Anatolia or similar ecologies was proposed for higher grain yields.

Key words: Faba bean, Poultry manure, *Vicia faba* L., Yield.

INTRODUCTION

Legumes are important sources of proteins and minerals for humans and animals (Pradhan *et al.,* 2014). Faba bean (*Vicia faba* L.) is extensively cultivated in Asia and Africa (Kaur *et al.,* 2013). Faba bean is among the first domesticated crops originating from Near East. Today it is a protein source used for feed and food worldwide and especially in Middle East, Mediterranean environment, Ethiopia and China. It is well adapted to diversified soil types (Cao *et al.,* 2017; Satovic *et al.,* 2013) and this helps the crop to ranks 4th in pulse production in the world (Abid *et al.,* 2015).

Faba bean is a rich source of minerals, nutrients (Khursheed *et al.,* 2018) and many bioactive secondary metabolites (Mekky *et al.,* 2020). It is a cheap source of protein (Mulugeta *et al.,* 2021). Faba bean is a prefered crop due to its palatability and ecological value in sustainable cropping systems (Uçar *et al.,* 2021). Protein content of Faba bean is higher than other pulses. This crop is mainly produced for dry seeds but its fresh pods or seeds are also used as vegetables in many countries. Sprouts of faba bean are also a part of human diet. Dried or fresh stems and leaves of the species are a good fodder for cattle and sheep. Diversified faba bean cultivation practices such as intercropping and rotation are well adopted to agricultural systems worldwide (Zong *et al.,* 2019). Faba bean-wheat rotation is a traditional system in many temperate, Mediterranean and tropical highland cropping regions (Nebiyu *et al.,* 2014).

Chemical fertilizers are main nutrient source to maintain soil fertility worldwide. Due to high cost of chemical fertilizers and environmental concerns, developing more economical and environmental substitutes is a requirement (Loh *et al.,* 2019). Increased consumption of poultry and its products is resulted with generation of millions of tonnes of manure globally (Fuchs *et al.,* 2018). Poultry manure is a locally available, relatively cheap and natural material. Inorganic fertilizers are more expensive and frequently contaminate environment (Masarirambi *et al.,* 2012). Poultry manure utilization as an organic fertilizer is helping to improve soil and crop productivity (Uçar and Erman, 2020; Dikinya and Mufwanzala, 2010). Poultry manure application is commonly practiced in horticultural sector due to its fertiliser value, soil property improvement ability and low cost (Ranadheera *et al.,* 2017).

Poultry manure includes a wide range of mineral elements and organic substances (Sushkova *et al.,* 2021). It is an excellent soil amendment due to rich nitrogen and phosphorous content (Han *et al.,* 2017; Espindola *et al.,* 2021).

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2021). Phosphorus forms in animal manure are different than synthetic phosphorus fertilizers (Kamran *et al.,* 2019). As a disadvantage, it is believed to increase the spread of antibiotic resistance from animal digestive systems the soil but instead, usage of this organic material for crop production is common worldwide (Yang *et al.,* 2016). Animal manures also usually contain high amounts of heavy metals (Bai *et al*., 2020). The application rate of poultry manure as fertilizer is limited due to its low N/P and C/P ratios (Vandecasteele *et al.,* 2014). This study was conducted to determine the effects of different doses of poultry manure on the yield and some yield components of faba bean crop under ecological conditions of Siirt province, Southern Eastern Anatolian Region of Turkey.

MATERIALS AND METHODS

Field trials were carried out in the experimental field of Siirt University Faculty of Agriculture Field Crops Department during 2017-2018 in Siirt province of Turkey. In the experiments, Salkım and Kıtık varieties registered by Aegean Agricultural Research Institute were used as faba bean seeds. Salkım and Kıtık are dry, suitable for grain consumption, upright growing, certified broad bean varieties (AARI, 2018). The study was carried out in randomized complete blocks design with 3 replications. The main plots were two varieties and the sub-plots were poultry manure doses. Monthly average temperature, monthly total precipitation and monthly average relative humidity for the first year (2017) of the experiment were 20.5°C, 321.7 mm and 44.7%, respectively; while the second year it was 22.0°C, 258.4 mm and 42.9%, respectively. The average temperature was above the long-term average for both years of the study (Table 1). While the amount of precipitation and average relative humidity values were above the long-term average in 2017, they were below the long-term average in 2018. The soils of the study fields were clayey loam, at pH 7.60, slightly calcareous (1.61%), poor in organic matter content 0.90%, poor in phosphorus (31.2 kg ha^{-1}) and rich in potassium (669 kg ha^{-1}) nutrients.

Previous crop in rotation was wheat. In autumn, the trial area was cultivated with a plow. In the spring, before sowing, a shallow cultivator and then harrow was applied. At pre-planting, 0 (control), 500, 1000, 1500 kg ha^{-1} of poultry manure was spread and mixed with a rake. Plant inter-row and intra-row spacings were 50 cm and 10 cm, respectively. The seeds were sown in four rows in each plot with a sowing depth of 4-5 cm conducted in the first week of March in both years. The plants were grown under rainfed conditions. Weeding was conducted manually by hand at four-six leaves stage of the crop. Pesticide was used to treat anthracnose disease. For observation and harvesting, one row from the edges of the plots and 0.5 m from the both ends of the plots cut out. 10 plants selected from the remaining plants for observations, except grain yield parameter. Parcel harvest was conducted for yield determinations. Plant height, first pod height, number of pods per plant, number of seeds per pod, 100-grain weight and grain yield were investigated. The plants were hand harvested and threshed in the first week of July. The data obtained as a result of the trials were analyzed in the JMP statistical package program.

RESULTS AND DISCUSSION

Based on 2017, 2018 and two years averages, all observed parameters were effected from poultry manure doses and variety factor (Table 2 and 3). Plant height was lowest at control (zero CM) and 500 kg ha^{-1} CM (49,42 and 50,65 cm respectively) and highest at 1000 and 1500 kg ha^{-1} CM application doses (55,1 and 54,92 cm) in 2017 (Table 2). In 2018, plant height was lowest at control (zero CM) (47,75 cm) and highest at 1000 and 1500 kg ha^{-1} CM application doses (54,91 and 54,48 cm). Salkım variety was taller than Kıtık variety based on 2017, 2018 and two years averages. Both varieties were taller in 2017 compared to 2018.

First pod height was lowest at control (zero CM) and 500 kg/ha CM (14,82 and 15,57 cm respectively) and highest at 1000 kg ha^{-1} CM application doses (16,97 cm) in 2017 (Table 2). In 2018, first pod height was lowest at control (zero CM) (13,01 cm) and highest at 1000 and 1500 kg ha^{-1} CM application doses (15,38 and 14,66 cm). First pod height of Salkım variety was higher than Kıtık variety based on 2017 and two years averages.

Pod number per plant was lowest at control (zero CM) (5,80 piece $plant^{-1}$) and highest at 1000 and 1500 kg ha^{-1} CM application doses (7,36 and 7,13 piece $plant^{-1}$,

Table 1: Meteorogical data of the research area**.

Months	Monthly average temperature (°C)			Monthly total precipitation (mm)			Monthly average relative humidity (%)		
	2017	2018	Long term average*	2017	2018	Long term average*	2017	2018	Long term average*
March	9,6	13,7	8,3	118,8	47,2	111,1	63,9	55,9	61,6
April	14,0	16,8	13,7	128,1	60,8	104,7	59,5	47,6	55,0
May	19,5	19,8	19,3	74,8	146,8	62,0	51,7	59,2	49,7
June	26,9	27,4	26,0	0,0	3,0	8,7	29,5	31,7	31,5
July	32,3	32,3	30,6	0,0	0,6	1,6	19,0	20,1	23,5
Aver./Total	20,5	22,0	19,6	321,7	258,4	288,1	44,7	42,9	44,3

*Long term average (1963-2018), **Turkish State Meteorological Service, Siirt Province Official Records.

Table 2: The effects of the applications on the plant height, the first pod height and the number of pods per plant values of the faba bean.

		Plant height (cm)			First pod height (cm)			Pod number per plant (piece plant^{-1})		
		Salkım variety	Kıtık variety	Mean	Salkım variety	Kıtık variety	Mean	Salkım variety	Kıtık variety	Mean
2017	Control	52,80b	46,05c	49,42B	15,05	14,60	14,82C	6,0bc	5,60c	5,80C
	500 kg ha^{-1}	53,35ab	47,95c	50,65B	16,05	15,10	15,57BC	6,13b	6,40b	6,26B
	1000 kg ha^{-1}	54,70ab	55,50a	55,10A	17,80	16,15	16,97A	7,53a	7,20a	7,36A
	1500 kg ha^{-1}	54,80ab	55,05ab	54,92A	16,30	15,65	15,97B	7,20a	7,06a	7,13A
	Mean of varieties	53,91A	51,13B	52,53	16,30A	15,37B	15,83A	6,71	6,56	6,64A
2018	Control	51,10d	44,40f	47,75C	13,30	12,73	13,01C	4,66	4,16	4,41D
	500 kg ha^{-1}	52,26c	48,13e	50,70B	14,43	13,66	13,95BC	5,06	5,13	5,10C
	1000 kg ha^{-1}	55,90a	53,93bc	54,91A	15,70	15,06	15,38A	6,23	6,10	6,16A
	1500 kg ha^{-1}	54,90ab	54,06bc	54,48A	14,90	14,43	14,66AB	5,96	5,63	5,80B
	Mean of varieties	53,79A	50,13B	51,96	14,53	13,97	14,25B	5,48	5,25	5,37B
TYA	Control	51,95c	45,22e	48,58C	14,17	13,66	13,92C	5,33d	4,88e	5,10D
	500 kg ha^{-1}	53,30b	48,08d	50,67B	15,14	14,38	14,76B	5,60cd	5,76c	5,68C
	1000 kg ha^{-1}	55,30a	54,71a	55,00A	16,75	15,60	16,17A	6,88a	6,65ab	6,76A
	1500 kg ha^{-1}	54,85a	54,55a	54,70A	15,60	15,04	15,32B	6,58ab	6,35b	6,46B
	Mean of varieties	53,85A	50,63B		15,41 A	14,67 B		6,10A	5,91B	
Tukey,	Year		NS			0,367			0,106	
TYA	CM		0,698			0,64			0,213	
	V		0,906			0,369			0,106	
	CM × V		1,186			NS			0,361	
Tukey,	CM		1,316			0,852			0,273	
2017	V		0,249			0,619			NS	
	CM × V		2,27			NS			0,474	
Tukey,	CM		0,725			1,087			0,365	
2018	V		2,795			NS			NS	
	CM × V		1,249			NS			NS	

TYA: Two years average; CM: Poultry manure; V: Variety; Different letters in the rows indicate significant differences according to Tukey's test (P≤0.05); NS: non-significant.

respectively) in 2017 (Table 2). In 2018, pod number per plant was lowest at control (zero CM) (4,41 piece plant^{-1}) and highest at 1000 kg ha^{-1} CM application doses (6,16 piece plant^{-1}). Pod number per plant of Salkım variety was higher than Kıtık variety based on two years averages.

Grain number per plant was lowest at control (zero CM) (21,30 piece plant^{-1}) and highest at 1000 kg ha^{-1} CM application doses (24,13 piece plant^{-1}) in 2017 (Table 3). In 2018, grain number per plant was lowest at control (zero CM) (20,28 piece plant^{-1}) and highest at 1000 kg ha^{-1} CM application doses (22,95 piece plant^{-1}). Grain number per plant was higher at Salkım variety than Kıtık variety based on 2017, 2018 and two years averages. Grain number per plant was higher for both varieties in 2017 compared to 2018.

100 grain weight was lowest at control (zero CM) (121,57 g) and highest at 1000 kg ha^{-1} CM application doses (130,6 g) in 2017. In 2018, 100 grain weight was lowest at control (zero CM) (117,88 g) and highest at 500, 1000 and 1500 kg ha^{-1} CM application doses (between 121,55-123,96 g) (Table 3). 100 grain weight of Salkım variety was higher than Kıtık variety based on 2017, 2018 and two years averages. 100 grain weight of both varieties were higher in 2017 compared to 2018.

Grain yield was lowest at control (zero CM) (1806 kg ha^{-1}) and highest at 1000 kg ha^{-1} CM application dose (2119 kg ha^{-1}) in 2017. In 2018, grain yield was lowest at control (zero CM) (1763 kg ha^{-1}) and highest at 1000 kg ha^{-1} CM application dose (2083 kg ha^{-1}) (Table 3). Probable reason for obtaining highest yield from highest poultry manure entry is cropping without any chemical fertilizer condition and the crop's positive reaction to macronutrients exist in poutry manure. Salkım variety was more productive in terms of grain yield than Kıtık variety based on 2017, 2018 and two years averages. Probable source for this varietal difference is higher pod number, grain number per plant and 100 grain weight of Salkım variety compared to Kıtık variety. Both varieties were yielded higher in 2017 compared to 2018. Lowest two years average grain yield (1759 kg ha^{-1}) was obtained from Kıtık variety at zero CM application dose. Highest two years average grain yield (2144 kg ha^{-1}) was obtained from Salkım variety at 1000 kg ha^{-1} CM application dose.

Table 3: The effects of the applications on the grain number per plant, 100-grain weight and the grain yield of the faba bean.

		Grain number per plant (piece plant^{-1})			100-grain weight (g)			Grain yield (kg ha^{-1})		
		Salkım variety	Kıtık variety	Mean	Salkım variety	Kıtık variety	Mean	Salkım variety	Kıtık variety	Mean
2017	Control	22,20	20,40	21,30C	124,55	118,60	121,57D	1811 e	1801e	1806D
	500 kg ha^{-1}	22,80	21,20	22,00BC	126,55	122,60	124,57C	1959cd	1906d	1932C
	1000 kg ha^{-1}	25,06	23,20	24,13A	132,75	128,45	130,60A	2166a	2072b	2119A
	1500 kg ha^{-1}	24,20	21,60	22,90B	130,05	124,00	127,02B	2125ab	1961c	2043B
	Mean of varieties	23,56A	21,60B	22,58A	128,47A	123,41B	125,94A	2015A	1935B	1975A
2018	Control	20,83	19,73	20,28C	120,76	115,00	117,88B	1808bc	1718c	1763D
	500 kg ha^{-1}	21,66	20,70	21,18BC	125,96	117,13	121,55A	1897b	1816b	1856C
	1000 kg ha^{-1}	23,73	22,16	22,95A	128,70	118,30	123,50A	2122a	2044a	2083A
	1500 kg ha^{-1}	22,30	21,03	21,66B	127,86	120,06	123,96A	2068a	1847b	1958B
	Mean of varieties	22,13A	20,9B	21,52B	125,82A	117,62B	121,72B	1973A	1856B	1915B
TYA	Control	21,51	20,06	20,79C	122,65	116,80	119,72C	1809e	1759f	1784D
	500 kg ha^{-1}	22,23	20,06	21,59B	126,25	119,86	123,06B	1928c	1861d	1894C
	1000 kg ha^{-1}	24,40	20,06	23,54A	130,72	123,37	127,05A	2144a	2058b	2101A
	1500 kg ha^{-1}	23,25	20,06	22,28B	128,95	122,03	125,49A	2096ab	1904cd	2001B
	Mean of varieties	22,85A	20,06B		127,15A	120,51B		1994A	1895B	
Tukey,	Year		0,425			1,098			8,23	
TYA	CM		0,704			1,774			28,46	
	V		0,425			1,098			8,23	
	CM × V		NS			NS			48,31	
Tukey,	CM		1,037			1,815			31,77	
2017	V		1,054			1,273			4,34	
	CM × V		NS			NS			54,77	
Tukey,	CM		1,098			3,362			52,42	
2018	V		0,791			3,148			25,16	
	CM × V		NS			NS			90,36	

TYA: Two years average; CM: Poultry manure; V: Variety; Different letters in the rows indicate significant differences according to Tukey's test (P≤0.05); NS.: non-significant.

Similar to this result, Yousif (1987) was found increase in yields (>25%), number of pods and seeds and plant heights with poultry manure application under Sudan ecological conditions. Also, Elsheikh and Elzidany, (1997) determined that poultry manure treatments to faba bean significantly increased yield and 100 seed weight values. In a field experiment conducted in Egypt by Gomaa *et al.,* (2010), application of poultry manure on faba bean increased seed yield (Gomaa *et al.,* 2010).

CONCLUSION

All observed parameters were effected from poultry manure doses. 1000 kg ha^{-1} poultry manure application was found superior interms of yield and yield related parameters. Grain yield was highest at 1000 kg ha^{-1} poultry manure application dose in 2017 and 2018, (2119 kg ha^{-1} and 2083 kg ha^{-1}, respectively). Salkım variety was superior in terms of grain yield and most of the other parameters. Temperatures were milder in 2017 compared to 2018 and this found a reflection in average year results. Both varieties were yielded higher and most of the parameters were higher in 2017 compared to 2018. As a result of the study, cropping Salkım faba bean variety with 1000 kg ha^{-1} poultry manure in South Eastern Anatolia or similar ecologies was proposed for higher grain yields.

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