The impact of organic and inorganic fertilizer on yield and yield components of common bean (*Phaseolus vulgaris*)

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ABSTRACT

Sustainable use of chemical fertilizers by Jordanian farmers has become a severe problem because of high cost, recently many researches focused on the using of organic fertilizers to reduces the cost of agricultural input. Field experiment was conducted to investigate the effect of chicken manure, chemical fertilizer NPK, and their combination on the productivity and yield components of common bean (*Phaseolus vulgaris*) during summer season (June-Sep), 2015 at a demonstration farm in Mutaa, South of Jordan. Four treatments were taken as NPK (15:15:15) 150 kg/ha, chicken manure at 20t/ha, combination of chicken 20t/ha manure with NPK (15:15:15) 150 kg/ha, and control (without fertilizer). The parameters investigated in the study were, plant height (cm), average of leaves number per plant, average of pods number per plant, fruit yield g per plant, and pod productivity t per ha. The experiment was laid out in a randomized complete block design (RCBD) with four replicates. The plot area was 9m² (3*3m). All fertilizer treatments had remarkable effect on all growth parameters and crop productivity. The results showed that the highest pod production 2.71 t per ha was achieved by the combination of chicken manure with NPK fertilizer followed by chicken manure 2.24t per ha, NPK 2.03t/ha, and control 1.55 t per ha. The highest value of pods weight per plant was recorded by the treatment of NPK 229g per plant compared to the control 83g per plant. The pods number per plants was significantly affected by all treatments at p<0.01, and the highest value 21 pods per plant was achieved by the combination of chicken manure with NPK. Chicken manure and NPK increase the productivity of common bean, but chicken manure is preferable because it is cheaper than chemical fertilizer and it is available in Jordan throughout the year.

KEYWORDS: Common bean, organic fertilizer, chemical fertilizer, yield components

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is a favorable vegetable in Jordan because of its delicious taste and moderate price, and it is available throughout the year. It can be used fresh as salad, cocked and as spices. The scientific name of common bean is *Phaseolus vulgaris* L. [1]. The common bean is a member of the legume family, and its taxonomic hierarchy is: Order Fabales, Family Fabaceae, Genus *Phaseolus* L., Species *Phaseolus vulgaris* L. Common synonyms are French bean, haricot bean, salad bean, snap bean, string bean, *frijoles* (Spanish), *feijão* and *feijoeiro* [2]. The genus *Phaseolus* is large, including approximately 80 cultivated and wild species, but *P. vulgaris* is the most widely cultivated species [3][4]. The most closely related species to *P.
vulgaris are P. albenscens, P. coccineus, P costaricensis, P. damosus, P. parvifolius and P. Persistens [5], [6], [7],[8].

It requires a warm, frost-free climate, but the plants may drop their flowers or pods during excessively hot temperature or rainy weather. The climate where common bean originated is sub-tropical to temperate, with defined wet and dry seasons, and bean prefers regions with moderate rainfall, rather than dry regions or areas with excessive rain [9]. Bean plants cannot tolerate frost, or elevations above 3000 meter, but they can grow as annuals in temperate climates and as annuals or short-lived. Excessive temperatures cause flowers to abscise, and low temperatures delay pod production and can result in empty pods. Common bean prefers well-drained, sandy clay or sandy loam soils, with balanced fertility and moderate acidity pH 5.8-6.5 [10].

Application of chemical fertilizers containing N, P and K not only increase crop yield but also improve nutritional quality of crop yields, such as protein, oil, starch, essential amino acids and vitamins in pulses, oil seeds, tubers, and vegetables respectively [11]. However, the intensive use of chemical fertilizers can result in undesirable changes in foods, and negative effects on atmospheric and aquatic environments [12]. Recently, many researches outcomes evidenced that sole application of mineral fertilizers does not provide sustainable soil fertility management, this is besides others factors such as delaying in delivery, poor transportation and marketing infrastructure which restrict the use of mineral fertilizers [13]. However, mineral fertilizers can serve an entry point for a comprehensive sustainable soil fertility management [14], [15]. The gradual soil fertility depletion is the main cause of crop yield decline and sustainable agricultural production. The major nutrients nitrogen (N), phosphorus (P) and potassium (K) are essential for growth and production of bean [16]. Beans are legumes that can fix atmospheric nitrogen (N2) into the soil in symbiosis with soil rhizobia. But besides N, P and K are needed, and in nutrient deficient soils bean yield can be greatly improved with the application of moderate rates of chemical fertilizers [17]. Application of organic resources was found to be as labour intensive, and low temperatures delay pod production and can result in empty pods. Common bean prefers well-drained, sandy clay or sandy loam soils, with balanced fertility and moderate acidity pH 5.8-6.5 [10].

This research focuses on the application of chemical fertilizer NPK (15:15:15), and chicken manure (20t/ha) to increase bean yields in the South of Jordan. Experiment was performed to evaluate chemical fertilizer, chicken manure and their combination on the productivity and yield components of common bean.

**MATERIALS AND METHODS**

Field experiment was conducted at the farm research center located in Mutaa, South Jordan, during summer season (June to September) of the year 2015. The experimental design used was randomized complete block with four replications. The treatments were; chemical fertilizer NPK (15:15:15) at 150 kg per ha, chicken manure at rate of 20t/ha combination of NPK and chicken manure and the control (without fertilizer). The plot area was 9m² (3*3m). The plots were separated by a distance of 1 meter from each other and 0.6 m between holes. Before sowing, seeds bed was prepared very well by ploughing and disking. Chicken manure was applied 15 days before sowing, chemical fertilizer NPK was applied at three doses with 15 days' interval and first dose was added at sowing. Ten guarded plants were tagged in each plot and then growth parameters data were taken before harvesting. Total yield was calculated by area then converted into t per ha, pods weight per plant was assessed by harvesting the pods from tagged plants and then using digital balance, pods and leaves number was assessed by visual counting and analysis of variance (ANOVA) and Fisher's least significant difference tests were used to analyse the differences among the treatments. Statistical analysis was carried out by using DSAASTAT[18].

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<tr>
<th>Table 1: Soil properties of the experimental site</th>
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<td>pH</td>
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**RESULTS AND DISCUSSION**

Plant height was significantly affected by all treatments at p<0.01 over control. NPK recorded the highest value 23.7cm followed by the combination of NPK with chicken manure 22.4 cm and chicken manure 22.13cm, whereas the control was 19.6cm. The difference between the two values of NPK and chicken manure was significant at p<0.05 (figure 1).
The number of leaves per plant was significantly affected by all treatments at \( p<0.01 \) over control. NPK recorded the highest average number of leaves per plant 21.4 leaves/plant followed by the combination of NPK and chicken manure 20.9 leaves/plant and chicken manure 20.4 leaves/plant whereas the control was 16.4 leaves/plant (Figure 2).

The pods number per plants was significantly affected by all treatments at \( p<0.01 \). Combination of chemical fertilizer with chicken manure recorded the highest value 21 pod per plant, however the difference with either NPK (20.8 pod/plant) or chicken manure (19.4 pod/plant) was not significant (Figure 3).
Fig. 3: Effects of treatments on the number of pods per plant.

All treatments were significantly increased the pods weight per plant in a comparison with the treatment of the control. Application of chemical fertilizer either alone or combined with chicken manure was affected the pods weight per plant significantly at \( p<0.01 \), whereas chicken manure affected the pod weight significantly at \( p<0.05 \). The highest value was recorded by the treatment of NPK 229g per plant compared to the control 83g per plant (Figure 4).

Fig. 4: Effects of treatments on the average pods weight per plant.

The productivity was affected by all treatments; however, there was no significant difference over the control. The combined use of chemical fertilizer with chicken manure recorded the highest yield production 2.71t per ha followed by chicken manure 2.24t per ha and NPK 2.03t/ha whereas the value recorded by the control was 1.55t/ha. (Figure 5)
Generally, application of NPK fertilizer increased yield and yield components of common bean, this result is in agree with other results of the same crop [19], [20]. Other researchers found that organic fertilizer increased growth, yield pods in cluster bean followed by chemical fertilizer as compared with the control [21].

The results also showed that chicken manure significantly increased yield and yield components of the crop. Another study showed that a combination of poultry manure with NPK increased the number of pods per plants of common bean [22]. The compost gave higher yield than sole NPK, and combination of compost with NPK [23]. Another study indicated that chemical fertilizers gave higher number of beans per pod, and higher yields per ha of common bean than bio-fertilizers and control treatments [24]. Organic fertilizer (cow manure) increased pod weight, pod dry weight, and total yield of French bean [25].

Positive response of common bean to chicken manure application could be due to the reduction of soil pH by the manure that makes the nutrient such as phosphorus more available to the plants. Using of poultry manure combined with NPK increased yield and yield component of maize plant [26]. Also another study that cow manure combined with chemical fertilizer increased yield and yield component of sweet maize [27]. All above results agreed with our results, which indicated that all treatments increased the productivity of common bean over control.

**Conclusion:**

This study has clearly demonstrated that common bean has positive response to chemical and organic fertilizer under the condition of south Jordan. However, there is need to determine the optimum rate of fertilizer under which common bean could have the highest yield. The study also suggests further research on examining the available sources of organic materials and their combined use with inorganic fertilizer for maintaining the soil and sustaining the productivity of the crop. Most of Jordanian farmers use chemical fertilizers rather than organic fertilizers may due to its fast effect on productivity, this study may contribute to convince those farmers to use organic fertilizers to improve the productivity of common bean and conserve sustainability instead of chemical fertilizer because it is cheaper than chemical fertilizer and it is available in Jordan throughout the year.

**REFERENCES**


