EFFECT OF FERTILIZATION AND SEED SIZE ON NODULATION, YIELD AND YIELD COMPONENTS OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract. This study investigated the effects of seed size and fertilizer usage with seed at planting on agronomic parameters of chickpea as a winter crop. The experiment was conducted according to split-split plots of randomized blocks with four replications. As factorial two chickpea varieties (Arda and Diyar 95), two fertilizer applications (with and without fertilizer) and three seed sizes (large, medium and small) are discussed in this study. The results showed that fertilizer applications along with seed at planting and large seed increased significantly the number of seed per plant, number of pods, biological yield, grain yield and 100-grain weight. However, fertilizer applications with large seeds had a negative effect on the output of the seeds and reduced grain yield per unit. In general, plants germinating from large seed had higher number of pods and number of seeds plant^{-1}, 100 seed weight, biological and seed yield plant^{-1}, while plants germinated from medium seed had higher emergence percentage, first pod hight, nodule fresh weight plant^{-1} and grain yield ha^{-1}. These effects tend to decrease in chickpea varieties having medium-grain weight as Arda. It was concluded that, application of fertilizer along with seed during the sowing time results in decreased emergence percentage of the seeds and lower the yield in chickpea.
Keywords: *field experiment, grain yield, leguminous plants, large seed, nitrogen, phosphorus*

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crop grown and consumed all over the world. It is a highly nutritious grain legume crop and is one of the cheapest sources of protein. Therefore, it can help people to improve the nutritional quality of their diets (Siddique and Sykes, 199). Chickpea is practiced as an important rotational crop in many parts of the world. When placed in rotation with other crops, it can enhance soil fertility, reduce rate of weeds, diseases and pests. Between the genetically factors, seed size has a special role in crop production. There have been very important studies on seed size in various plant species. The effect of seed size on germination, ground cover and performance of plant has been confirmed. Seed size is one of the most important characteristics of seeds that can affect the duration of seed development. Generally big seeds with higher amount of initial food reserves germinate early with exhibiting uniformity and grow vigorously in field and shows early advantages of plant vigour with respect to plant performance and yielding ability as compared to small and medium seeds in several crops (Adebisi et al., 2011: Jerlin and Vadivelu., 2004). On the contrary in some crops even medium, small and bulk seeds were also found to have equal advantageous results as that of

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big seeds with respect to field performance. The small and medium seeds require less moisture for germination, germinate early, establish early, grow vigorously and yield equally as that of big seeds (Dar et al., 2002: Peksen et al., 2004).

Farokhi and Galeshi (2005) and Grant and James (2000) reported that there is a negative correlation between soybean tolerance to climatic factors and its seed size, because large seeds require more water resources for their vital activities and consequently they can be damaged by reduction of osmotic potential. Adebisi et al. (2013) with a study on soybean seed size differences reported that determination of the effects of seed size on yield and yield components of soybean and other important legumes has highest importance and seed size in soybean is influenced by genetic and environmental factors. As the seed size per seed is still a controversial issue and there is a need to investigatethe influence of seed size on plant growth, seed yield and quality in Kabuli and Desi chickpea varieties as they show much variations in seed size.

Nitrogen and phosphorus are among essential elements for the plant growth and development and plays an important role in the sufficient grain production. The evolution of science, especially in the last century, has openly showed the importance of phosphorus for all animal and plant life on the earth (Ryan et al., 2012). Particularly during the initial stages of plant growth, sufficient amount of phosphorus is required for development of the reproductive parts and it has a positive effect on root growth, early maturity, and reduced disease incidence. Methods of applying fertilizers can greatly affect their agronomic effectiveness. To avoid economic loss and soil depletion, it is necessary to determine the proper method of fertilizer application in chickpea. Shahzad et al. (2003) reported that fertilizer placement below the seed results in significantly high yield followed by side drilling on both sides of the seed rows, while minimum seed yield was recorded with the broadcast method. Chickpea is usually managed with low fertilizer input, and has shown variable growth pattern and yield response to fertilizer application. There is little research on combined effects of fertilizer application and seed size on yield and yield components of some legume crops as chickpea. Therefore, the present study aimed to assess the effects of seed size and fertilizer application along with seed at planting on yield and yield components of chickpea.

Material and Methods

This study was conducted for 2 consecutive years (during the winter of 2011-12 and 2012-13) at an experimental site in the GAP International Agricultural Research and Training Centre, Diyarbakır, Turkey (37°56' N, 40°15' E and altitude 612 m above mean sea level). Climatically, the area placed in the semi arid temperate zone with cold winter and hot dry-summer. The average annual precipitation is around 484 mm and most of the precipitation falls in the winter and spring months. The soil of trial area was clayey-loamy, with pH about 8.02 and EC about 2.6 ds m^{-1}. The trial was laid out in randomized complete block design with split-split plot arrangement keeping varieties in main plots, fertilizer aplications (unfertilized and fertilized) in sub plots and seed size (small, medium and large) in sub-sub plots with four replications. Seeds of each variety were divided into three seed size classes (small ≥7 mm, medium ≥ 8 and large≥ 9 mm) using by laboratory test sieves. Plots consisted of four rows, 6 m in length, with 45 cm row spacing and 10 cm between plants. Seeds of each variety were sown in the first week of December in both years and plant density for each variety was 45 seed m^{-2}. For fertilized plots 150 kg per hectare DAP (Di amonium phosphate, which contains 18 %

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N and 46 % P_2O_5) were applied in planting time by sowing machine. Weed control was supplemented over the growth period with hand weeding. Yield components such as emergence percentage, plant height, first pod hight, number of pods plant^{-1}, number of seeds plant^{-1}, biological yield plant^{-1} and seed yield plant^{-1} was recorded on 10 randomly selected plants. Grain yield per hectare and 100 seed weight was defined by harvesting the middle two rows of each plot. Nodule fresh weight plant^{-1} was conducted at the 50% flowering time. For all treatments, six plants were selected from two side rows, and tenderly uprooted. The roots were washed with water to take out the adhering soil. The nodules were cut off from the roots, and nodules fresh weight per plant were recorded. To see the effect of factors (cultivars, fertilizer application and seed size) on the examined parameters. The obtained results were subjected to the analysis of variance (ANOVA), using the MSTAT-C software. Treatment mean differences were calculated by the least significant difference (LSD) test at 0.05 probability level.

Results and Discussion

Effect of cultivars on nodulation, yield and yield components of chickpea

The results of ANOVA for nodulation, yield and yield components are briefly described in Table 1. The results of the variance analysis showed that the effect of cultivars on PH and FPH, NSP, BY, GY and 100 SW was significant in 1% probability level and there was no significant effect for EP, NPP, NFWP and SY.

The highest values were obtained from Diyar 95 cultivar for plant height (56.7 cm), first pod height (35.8 cm), BY (42.5 g) and 100 seed weight(37.8 g), while the highest values obtained from Arda cultivar for number of seeds plant^{-1} (43.4 seeds) and grain yield (3677 kg) (*Table 1*). El-Habbasha et al. (2012) also found the similar results.

Effect of fertilizer application along with the seed at planting on nodulation, yield and yield components of chickpea

Data presented in *Table 1* showed that the effect of fertilizer application along with the seed at planting on EP, NPP and NSP, NFWP, BY, SY and GY were significant in 1% probability level. But 100 SW, PH and FPH differences were not significant for fertilizer applications. Bicer (2014) reported that the effect of phosphorus application on PH and 100 SW was not significant, but the effect of phosphorus fertilizer application on NPP and NSP was significant. The highest NPP (40.4 pods), NSP (46.1 seeds), BY (44.1 g) and SY (17.7 g) were recorded at the fertilized plots, while the highest EP (94.6 %), NFWP (2.27 g) and GY (3891 kg) were obtained from unfertilized plots (*Table 1*). Similar findings have also been reported by Sahin and Gecit (2006). Pochiman (1991) reported that phosphoruse plays a key role in various physiological processes concerning root production, nodulation, seed formation and also improves the seed quality.

Effect of seed size on nodulation, yield and yield components of chickpea

Results of this two year study revealed that seed sizes significantly ($P < 0.01$) affected all measured parameters, except PH (*Table 1*). The highest values were obtained from medium seed sizes for EP (90.8 %) , FPH (34.1 cm), NFWP (2.23 g) and GY (3772 kg), while the highest values obtained from large seed sizes for NPP (40.8 pods), NSP (44.4 seeds), BY (42.7 g) and SY (17.7 g) and 100 SW (38.4 g). In general the lowest values were recorded at the small seed sizes, except EP, PH, FPH and GY.

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Table 1. *Effect of fertilizer application along with the seed at planting and seed size on nodulation, yield components in chickpea* (*Cicer arietinum* L.)

Parameters	EP	PH	FPH	NPP	NSP	NFWPP	BY	SY	GY	100 SW
Variety	Ns	**	**	Ns	**	Ns	**	Ns	**	**
Arda	89.9	52.4 b	30.5 b	37.2	43.4 a	1.75	35.0 b	15.30	3677 a	34.9 b
Diyar-95	87.6	56.7 a	35.8 a	37.6	40.3 b	1.59	42.5 a	16.10	3546 b	37.8 a
Fertilizer Application (F)	**	ns	Ns	**	**	**	**	**	**	ns
Fertilized	83.1 b	54.5	32.7	40.4 a	46.1 a	1.07 b	44.1 a	17.7 a	3332 b	36.30
Unfertilized	94.6 a	54.7	33.6	34.4 b	37.6 b	2.27 a	33.5 b	13.7 b	3891 a	36.40
Seed size (S)	**	ns	**	**	**	**	**	**	**	**
Large seeds (>9mm)	88.0 b	54.3	32.3 b	40.8 a	44.4 a	1.74 b	42.7 a	17.7 a	3336 b	38.4 a
Medium seeds (>8mm)	90.8 a	54.6	34.1 a	35.8 b	42.6 a	2.23 a	37.4 b	14.2 b	3772 a	36.2 b
Small seeds (>7m)	88.6 b	54.9	33.2 ab	35.5 b	38.6 b	1.03 c	36.2 b	15.3 c	3727 a	34.6 c
V x F	Ns	ns	Ns	**	**	*	**	**	Ns	ns
V x S	**	**	*	**	**	*	**	**	**	**
F x S	**	*	**	**	**	*	*	*	Ns	ns
V x F x S	**	*	*	**	Ns	Ns	**	ns	Ns	**
CV (%)	2.14	2.97	3.66	4.93	4.37	13.30	4.65	6.38	7.17	1.01

**: significant at level 0.05, **: significant at level 0.01, ns : non-significant, EP: Emergence percentage, PH: Plant height, FPH: First podheight (cm), NPP: Number of pod plant^{-1} , NSP: Number of seed plant^{-1} , NFWPP: Nodule fresh weight (g plant^{-1}), BY: Biological yield, SYP: Seed yield plant^{-1} , GY: Grain yield (ha^{-1}), SW: 100 seed weight (g)*

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Bhingarde and Dumbre (1993) reported that large sized seed gave higher NPP and smaller size seed gave lower NSP in mungbean. Kamal et al. (2001) reported that yield is positively associated with seed size in groundnut. The present findings are in agreement with the findings of Bhingarde and Dumbre (1993).

Effect of interactions on nodulation, yield and yield components of chickpea

Varieties with direct fertilizer applications during the time of sowing interact significantly ($P < 0.01$) for NPP and NSP, BY and SY, while for NFWP, there was significant differences in 1% probability level for this interaction (*Table 1*). The highest value of number pods (43.8 pods), NSP(48.4 seeds), BY (52.0 g) and SY (19.4 g) was obtained from Diyar 95 with fertilized application, while the highest NFWP (2.44 g) was obtained from Diyar 95 × unfertilized treatment (*Figures 1 and 2*) .

The interaction effect of cultivar and seed sizes on EP, plant hight, NPP and NSP plant, BY and SY, grain yield hectare^{-1} and 100 SW were significant in 1% probability level and FPH and NFWP significant in 5% probability level (*Table 1*). Hojjat (2011) reported that the germination parameters were significantly related by seed weight and large seeds germinated earlier and indicated better germination than small seeds of lentil genotypes. Similar results were obtained from Roozrokh et al. (2005) on chickpea.

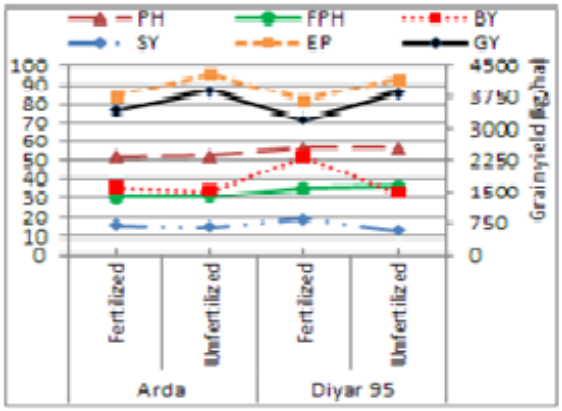

Figure 1. *Interaction effect of variety and fertilizer application on plant heiht, first pod hegiht, biological yield plant-1, seed yield plant-1 and grain yield hectare-1*

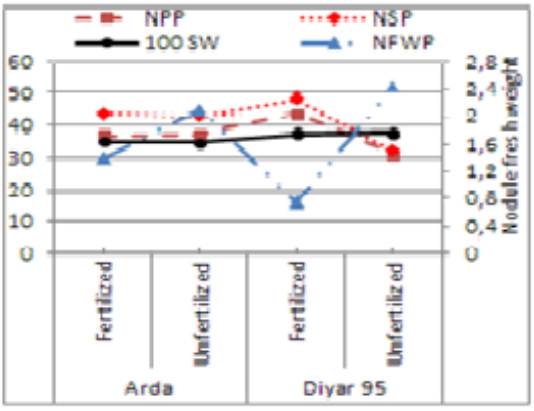

Figure 2. *İnteraction effect of variety and fertilizer application on number of pod plant-1, number of seed plant-1, nodule fresh weight plant-1 and 100 seed weigh*

The interaction effects of cultivar and seed sizes showed the highest 100 SW (40.9 g), NPP (45.4 pods) and NSP (45.3 seeds) , BY (48.2 g) and SY (18.6 g) in the Diyar 95 × large seed sizes; the highest GY (4000.0 kg), plant (57.7 cm) and FPH(37.7 cm) in the Diyar 95 × medium seed sizes; the highest EP (93.4%) and NFWP (2.53 g) in the Arda × medium seed sizes treatment (*Figure 3, 4 and 5*). Eser et al. (1991) reported that the genetic nature of the varieties and the high vigor of the large seeds as compared with the small seeds can affer to justify such differences.

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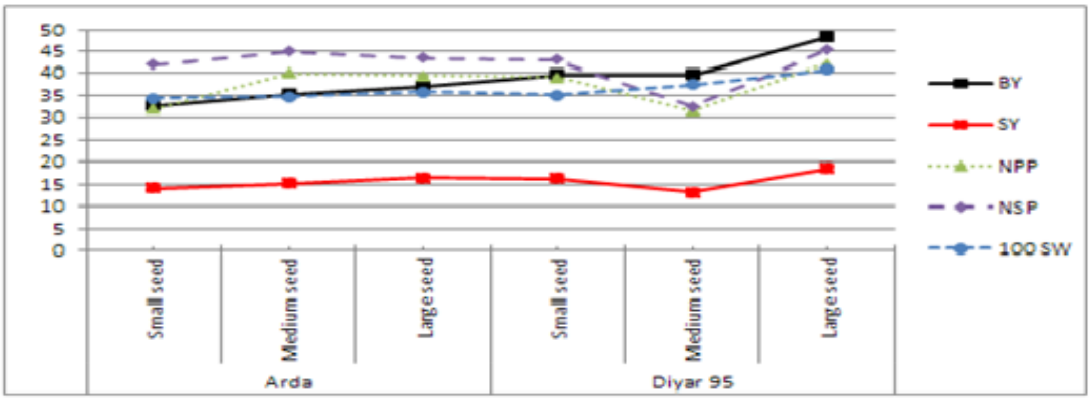
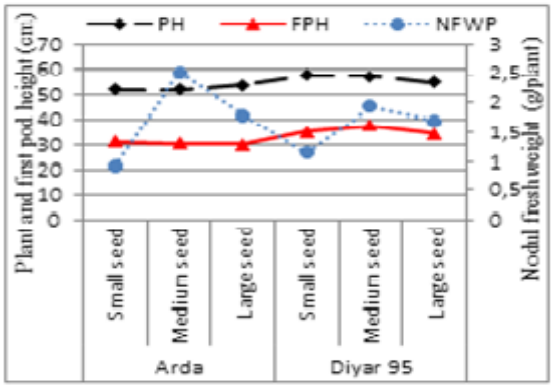


Figure 3. *Interaction effect of variety and seed size on number of pods plant-1, number of seeds plant1, biological and seed yield plant-1and 100 seed weight*



Figue 4. *Interaction effect of variety and seed size on plant height, first pod height and nodule fresh weight plant*$^{-1}$

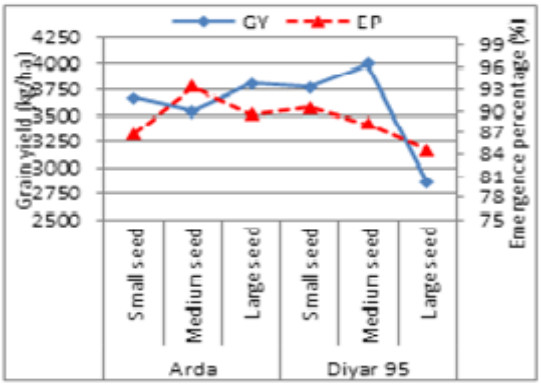


Figure 5. *Interaction effect of variety and seed on plant heiht, first pod hegiht and nodule fresh size emergence percenge and grain yield hectare*$^{-1}$

Those plots where fertilizer was applied during the sowing time and lage size seeds were sown achieved the maximum value of number pods plant^{-1} (44.9 pods), NSP(48.6 g), BY (48.6 g), seed yield (19.6 g) and 100 SW (38.5 g), while the highest plant (55.5 cm) and FPH (35.0 cm) was recorded from fertilized × medium seed size treatment (*Figs. 6 and 7*).

The highest EP (95.7 %) and grain yield (4010.2 kg ha^{-1}) were recorded from unfertilized × small seed size treatment. Generally FPH and grain yield in unfertilized treatment was higher than fertilized treatment (*Figure 8*). This is related to direct fertilizer application below the sown seed. This application leads to increase the risk of burning the roots of the sown seeds, especially during dry conditions. Mahli et al. (2001) reported that fertilizer application below the sown seed leads to increase the risk of burning the roots of the sown seeds. Thus the percentage of seed emergence was influenced by the used fertilizer placement and consequently, the yield per unit area decreased.

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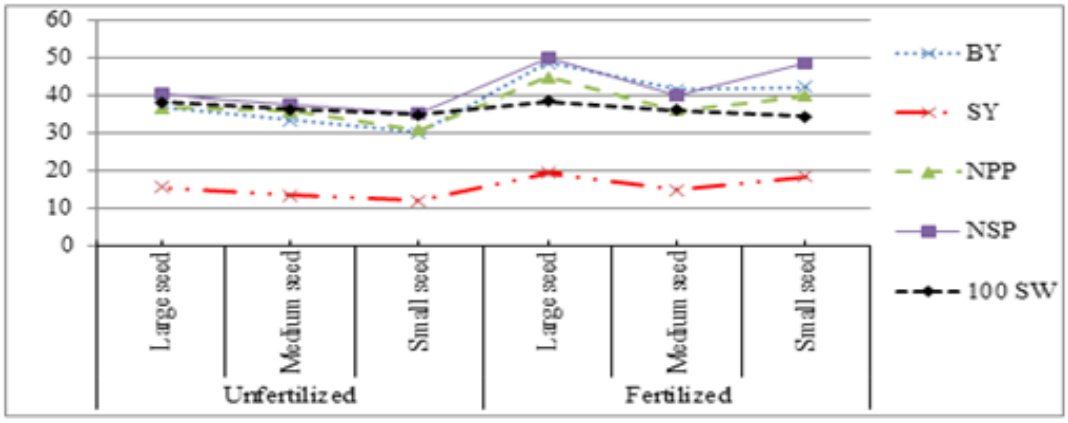

Figure 6. *Interaction effect of fertilizer application and seed size on number of pods plant^{-1}, number of seeds plant^{-1}, biological and seed yield plant-1and 100 seed weight*

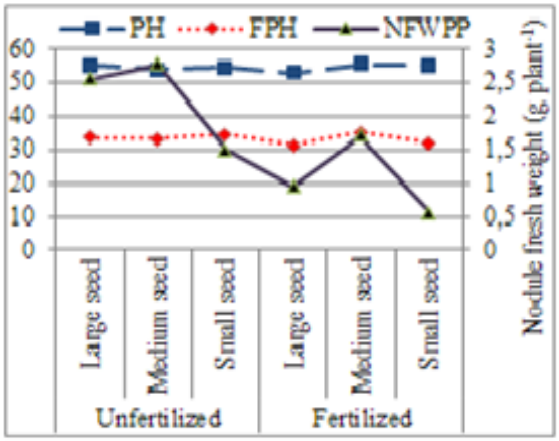

Figure 7. *Interaction effect of fertilizer application and seed size on plant heiht, first pod hegiht and nodule fresh weight plant^{-1}*

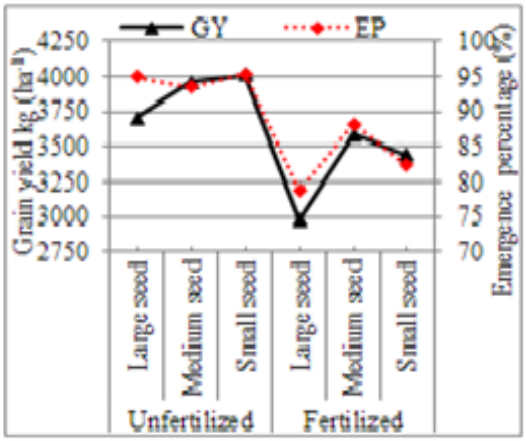

Figure 8. *Interaction effect of fertilizer application and seed size on emergence percentage and grain yield hectare^{-1}*

Conclusions

Results obtained from this study indicated that the effect of fertilizer application along with seed during the sowing time was significant for other examined characteristics, except plant height, FPH and 100-grain weight. This effect was negative on emergence percentage, grain yield and nodule fresh weight. Seed size affected all studied features of chickpea, except plant height. In general, plants originating from large seed had higher number of pods and number of seeds plant^{-1}, 100 seeds weight, biological and seed yield plant^{-1}, while plants originating from medium seed had higher emergence percentage, first pod hight, nodule fresh weight plant^{-1} and grain yield ha^{-1}. However, these effects tend to decrease in chickpea varieties having medium-grain weight (37 g 100 seeds^{-1}) as Arda. The increase in grain yield was associated with emergence percentage. Furthermore, variety × seed size and fertilizer application × seed size interaction had significant effects on yield and its components. Consequently application of fertilizer along with seed at planting can cause to decrease emergence percentage of the seeds and this can cause to yield loss. Therefore, do not let fertilizer contact with seed.

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