

INFLUENCE OF SEED SIZE, PLNTING EPTH AND PHOSPHORUS FERTILILIZATION LEVEL ON AND YIELD COMPONENTS CHARACTERS OF LOCAL BROAD BEAN (*VICIA FABA L.*).

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ABSTRACT

A field experiment was carried out at two sites (Erbil and Mosul) in winter season 2017-2018, to study the effect of three different seed size (small, medium and large) of local broad bean planted in three sowing depths (5, 10 and 15 cm) using three levels of phosphate fertilizer (zero, 75 and 150 kg P₂O₅. ha⁻¹) in yield and yield components. The experiment executed according to the (R.C.B.D) design and Duncan Multiple range used to compare between treatment means. The results showed that there was no significant effect of seed sizes in most studied traits; The pod length, 100 seeds weight and seeds yield were surpassed at depth (15 cm) at both sites. The number of pods / plant, 100 seeds weight, seeds yield, and biological yield increased significantly at the second and third fertilization levels at both sites. Pod length, number of seeds / pod and harvest index have exceeded significantly in the second level of fertilization at both sites. The second order interactions showed significant differences between most studied characters.

Key words: broad bean, yield, sowing depth, phosphorus fertilization.

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INTRODUCTION

Broad bean (*Vicia faba L.*) is one of the most important legume crops, it is the cheapest source of protein used in poor countries, the protein percent of in the seeds ranged between (25-40%) (Natalia et al, 2008), also the seeds have high contain about percent (56%) carbohydrate, minerals, fibers and vitamins in addition to its benefit of raising soil fertility (Carmen et al, 2005). The total area planted for green pods in Iraq is (71578) donum (Iraqi donum = 2500 m²) produce (140542) tonnes, the mean yield (1.963) tonnes / donum as green pods (Central Bureau of Statistics and Information Technology, 2010). The area cultivated to produce dry seed in Iraq is (350,000) with mean yield (314 kg.ha⁻¹) (Arab Agricultural Development Organization, Khartoum, 2012). Selecting the appropriate size of seeds and determining the convenient depth of sowing may have positive impact on increasing yield due to the increasing of rate, speed of germination and establishment, which ultimately reflects on yields. Some studies were carried out to determine the best size of broad bean seed, Hussain et al. (2013) found that large seeds planted in depth (4 and 8cm) surpassed in seed germination percent. Mekkei (2014) found a significant superiority of plants grown from large seeds comparing with medium and small seeds particularly in 100 seed weight and seed yield, but the seed size did not affect the number of pods /plant, number of seeds /pod, biological yield, and harvest index. Siddig and Idris (2015) found that the germination% of medium and large seeds which planted in (5cm) depth increased comparing with small seeds, nevertheless they did not observe significant differences in germination % between the sowing

depths. However, Idris (2008) did not observe significant differences between four different seed sizes in number of pods /plants, number of seeds / pod, 100 seed weight and seed yield. Al-Anbari et al. (2010) observed that (10cm) depth surpassed in seed yield comparing with (5 and 15cm) depth. (5cm) depth surpassed in 100 seed weight. Singh et al. (2010) observed a significant superiority of the large seeds sown at (12 cm) depth in the number of days to germination comparing with small, medium and large seeds at the depths (4 and 8 cm); The (medium sized) seeds planted in (4cm) depth surpassed in seed yield in contrast to (small, large and very large) seed planted on (4, 8 and 12 cm) depth. The small seeds sown at (4cm) gave the longest pods, highest number of pods /plant and seeds/ pod. Issa (2009) reported a significant superiority with (120 kg P₂O₅.ha⁻¹) in the number of pods /plant, 100 seed weight and seed yield comparing with (0 and 100 kg P₂O₅.ha⁻¹). Hashemdhadi (2013) different from refer list study the impact of phosphate levels (0, 40, 80, 120 kg P₂O₅. ha⁻¹) in yield and yield components of broad bean, the researcher did not notice any significant differences between all levels of fertilization on the number of pods / plant, 100 seed weight and seeds yield. Huthily and al-Hassani (2014) noticed that phosphate fertilization with (120 kg P₂O₅ kg. ha⁻¹) have positive effect in the number of pods / plant, number of seeds /pod, 100 seed weight and seed yield /plant comparing with (zero P₂O₅ kg. ha⁻¹). Kubure et al. (2016), use two levels of phosphate fertilization (0 and 46 kg P₂O₅. ha⁻¹), on three broad beans genotype, the fertilizer dose (46 kg P₂O₅. ha⁻¹) surpassed in pod length, 100 seed weight, seed yield and biological yield, while the number of days for maturity, number of pods /plant and harvest index did not affect. Sarkar et al. (2017) found that phosphate fertilization rate (75 kg P₂O₅. ha⁻¹) increase the number of seeds / pod, 100 seed weight and seed yield comparing with (0, 25, 50 P₂O₅ kg. ha⁻¹). The current study aims to find the effect of treatment combination of three size different seed (small, medium and large) planted in three depths (5, 10, 15 cm) with three levels of phosphate fertilization (0, 75 and 150 kg P₂O₅. ha⁻¹) on yield and yield components of the local broad bean crop.

MATERIAL AND METHODS

A field experiment was carried out in two locations, the first at private farmer field in Erbil and the second in the Field of Crops Department / Collage of Agriculture and Forestry / University of Mosul, during growing season 2017/2018. The experiment included three factors: The first is three different seed sizes of local broad bean i.e. small (700-1000 mg / seed), medium (1001-1500 mg / seed) and large (more than 1500 mg / seed) according to (Al- Riffae et al, 2004) and (Mekkei, 2014) methods, The second factor is three sowing depths (5, 10, 15 cm) and the third factor is three levels of phosphate fertilization (0, 75, 150 kg P₂O₅.h⁻¹) in the form of triple super phosphate (46% P) added at the beginning of sowing. Mosul site was planted in (4/12/2017), Erbil was at (7/12/2017), the field divides to three replicas each one contain (27) experimental units due to the number of combination treatments by using Randomized Complete Block Design (R. C. B. D).The experimental unit consist of four lines each Randomized at (3m) length, the distance between lines (60 cm) and between plants (30cm). Urea Fertilizer (44 kg/ ha) was added to all the experimental units, half dose after germination and the remainder at the beginning of the flowering stage, as recommended by (Boras et al 2006). The data were analyzed according to

the (R.C.B.D) design, Duncan multiple range test (1955) treatment. The percentage of field emergence was calculated from the number of grown seeds to the number of planted seeds per experimental unit. Then ten plants were randomly taken from the median lines to calculate the maturity of (50%) of pods, mean of pod length (cm), number of pods /plant, number of seeds / pod (by dividing the number of seeds by the number of pods for (10) plants, seed index (gm) as (100) seeds weight, seed yield (gm /Plant), biological yield (gm /plant) which represents the weight of the total dry mater, and the Harvest index (HI) (%) using the formula mentioned by (Sharma and Smith, 1986) Harvest index = (seed yield / biological yield) × 100.

RESULTS AND DISCUSSION

Final germination % (field emergence):

The results in table (1) showed that the final emergence % was not affected by the seed sizes at both sites. The final emergence % in the seeds sown at (10 cm) depth surpassed significantly in two locations, the low germination % in (5 cm) depth is due to the lack of moisture in the surface layer. While the reduction of final germination in depth (15 cm) may be due to mechanical resistance of penetration of the plumule (shoot) to soil then the failure in emergence is larger in comparison to (10 cm) depth, these results corresponds to the findings of Singh et.al (2010). Fertilizer rates showed no significant differences on field emergence at both sites. The interaction between seed sizes and depth was highest at (10 cm) depth despite of seed sizes at both sites. Interaction between seed sizes and fertilization did not significantly affect this character in both sites. The highest final emergence % in the interaction between depths and fertilizer doses in both location was recorded for the depth (10 cm) with all fertilizers levels (0, 75 and 150 kg P₂O₅. ha⁻¹). In the tri-interaction, the highest percentage of final emergence at both site was recorded for all seed size at all levels of fertilization sown at (10 cm) depth.

The number of days until maturity of 50% of pods:

From table (2) there was no significant difference in the number of days to maturity of 50% of the pods between the seed sizes in two locations. The number of days was decreased significantly at (5 and 10cm) depth comparing with (15 cm) in Erbil location, while there was no significant differences at Mosul location. Maturity of 50% of pods decreased significantly in third level of the fertilization in Erbil location, this results agree with Kubure et al (2016). The number of days to maturity of 50% of the pods increased significantly at the depth (15 cm) with small and medium seeds at Erbil location (139 days) for both size, while there were no significant differences of this interaction in Mosul, this due to the environmental conditions between the sites. The interaction between the seeds size and levels of

Table (1): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on final field emergence.

Erbil location					
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	69.5 j	72.0 ij	74.4 hi	71.9 c
	10	83.2 a-c	83.2 a-c	84.3 ab	83.6 a
	15	79.6 c-g	80.3 b-g	77.0 gh	79.0 b
Medium	5	71.0 ij	70.8 ij	72.6 ij	71.5 c
	10	81.7 b-f	84.4 ab	82.6 a-e	82.9 a
	15	79.1 c-g	78.7 e-g	77.9 f-h	78.6 b
Large	5	71.5 ij	71.0 ij	72.9 ij	71.8 c
	10	82.9 a-d	81.1 b-g	86.3 a	83.4 a
	15	78.9 d-g	82.0 b-f	78.0 fg	79.6 b
fertilizers mean		77.5 a	78.2 a	78.4 a	
Size		Size X fertilizers mean			Size mean
Small		77.4 a	78.5 a	78.6 a	78.2 a
Medium		77.2 a	78.0 a	77.7 a	77.6 a
Large		77.8 a	78.0 a	79.0 a	78.3 a
Depth		Depth X fertilizers mean			Depth mean
5		70.6 e	71.3 de	73.3 d	71.7 c
10		82.6 a	82.9 a	84.4 a	83.3 a
15		79.2 bc	80.4 b	77.6 c	79.1 b
Mosul location					
Small	5	71.4 g	73.4 fg	77.4 c-e	74.0 c
	10	86.2 a	86.7 a	85.7 a	86.2 a
	15	79.5 c	80.0 c	77.2 c-e	78.9 b
Medium	5	73.4 fg	73.4 fg	73.9 e-g	73.5 c
	10	86.3 a	85.6 a	85.9 a	85.9 a
	15	80.5 c	81.1 bc	77.4 c-e	79.6 b
Large	5	73.9 e-g	73.7 e-g	75.2 d-f	74.2 c
	10	87.0 a	84.2 ab	86.9 a	86.0 a
	15	80.2 c	80.8 bc	78.5 cd	79.8 b
fertilizers mean		79.8 a	79.8 a	79.8 a	
Size		Size X fertilizers mean			Size mean
Small		79.0 a	80.0 a	80.1 a	79.7 a
Medium		80.0 a	80.0 a	79.1 a	79.7 a
Large		80.3 a	79.6 a	80.2 a	80.0 a
Depth		Depth X fertilizers mean			Depth mean
5		72.9 e	73.5 e	75.5 d	73.9 c
10		86.5 a	85.5 a	86.2 a	86.0 a
15		80.0 b	80.6 b	77.7 c	79.4 b

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

Table (2): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on number of days until (50%) maturity of the plants

Erbil location					
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	137.6 ab	138.0 ab	136.6 ab	137.4 ab
	10	139.0 a	136.6 ab	136.6 ab	138.0 ab
	15	140.0 a	138.0 ab	139.0 a	139.0 a
Medium	5	136.6 ab	138.6 ab	135.3 b	136.8 b
	10	137.6 ab	138.6 ab	137.0 ab	137.7 ab
	15	140.0 a	137.3 ab	139.6 a	139.0 a
Large	5	138.3 ab	138.6 ab	138.3 ab	138.4 ab
	10	138.3 ab	138.0 ab	137.3 ab	137.8 ab
	15	139.0 a	137.6 ab	138.6 ab	138.4 b
fertilizers mean		138.5 a	138.1 b	137.6 c	
Size		Size X fertilizers mean			Size mean
Small		138.8 a	138.1 a	137.4 a	138.1 a
Medium		138.1 a	138.2 a	137.3 a	137.8 a
Large		138.5 a	138.1 a	138.1 a	138.2 a
Depth		Depth X fertilizers mean			Depth mean
5		137.5 bc	138.4 a-c	136.7 c	137.5 b
10		138.3 a-c	138.3 a-c	137.0 c	137.8 b
15		139.6 a	137.6 bc	139.1 ab	138.8 a
Mosul location					
Small	5	135.3 ab	137.3 a	135.6 ab	136.1 a
	10	135.0 ab	136.6 ab	137.0 ab	136.0 a
	15	137.3 a	136.6 ab	136.6 ab	136.8 a
Medium	5	135.6 ab	136.6 ab	137.3 a	136.5 a
	10	137.0 ab	137.6 a	135.6 ab	136.7 a
	15	137.0 ab	135.0 ab	135.6 ab	135.8 a
Large	5	133.6 b	136.0 ab	138.0 a	135.8 a
	10	134.6 ab	137.3 a	136.0 ab	136.0 a
	15	137.6 a	137.6 a	136.0 ab	137.1 a
fertilizers mean		136.0 a	136.5 a	136.4 a	
Size		Size X fertilizers mean			Size mean
Small		136.2 a	136.3 a	136.4 a	136.3 a
Medium		136.5 a	136.4 a	136.2 a	136.4 a
Large		135.3 a	137.0 a	136.6 a	136.3 a
Depth		Depth X fertilizers mean			Depth mean
5		134.8 b	136.6 ab	137.0 a	136.1 a
10		135.8 ab	136.6 ab	136.2 ab	136.2 a
15		137.3 a	136.4 ab	136.1 ab	136.6 a

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

fertilization did not affect the number of days until maturity of 50% of the pods at both sites. The interaction between the depths and fertilization showed that (5 and 10 cm) depths with (150 kg P₂O₅.ha⁻¹) decrease the day to maturing at Erbil only, and at (5 cm) depth with the (0 kg P₂O₅.ha⁻¹) at Mosul. In the triple interaction the maximum number of days to 50% of maturity was recorded for the small seeds at a depth of (15 cm) without fertilization (140 days) with a delay of about (4.7 days) from medium seeds planted at (5 cm) depth in Erbil. at Mosul site the difference in the number of days till maturity of large size seeds sown at (5 cm) depth with the third level of fertilization and plants growing from large seeds at (5 cm) depth with the level of fertilization (zero) was (4.4 days). In general the plants were matured earlier at Mosul than Erbil perhaps the temperature was higher at Mosul which leads to accelerate at maturation.

Pod length (cm):

Seed size did not affect the pod length at both sites (table 3), but the length of the pods from plants of (15 cm) depth exceeded significantly comparing with those planted at (5 and 10 cm) depth at both sites. The plants fertilized with (75 kg P₂O₅.ha⁻¹) exceeded significantly the pods length at both sites, the third level of fertilizer did not differ from that at Mosul only while the pod length decreased significantly at zero level in phosphate at both sites. The pod length increased significantly at (15 cm) depth despite of seed sizes, while the pod length decreased significantly whenever the depth is reduced in Erbil, Generally (10 and 15 cm) depth positively affect most studied traits, this effect attributed to the high moisture content in these depths especially at (15 cm), these results were similar at Mosul location. In the interaction of seeds size and fertilization levels the pod length increased significantly at (75 kg P₂O₅. ha⁻¹) for all sizes of seed (small, medium and large) at both sites, in addition to the third level of fertilization at Mosul site, this was coincided with the results of Kubure et al (2016). The pod length increased at (15 cm) depth with the three levels of fertilization at Erbil site and with the second and third Level of fertilization at Mosul site. In the triple interaction the longest pods produced at (15 cm) depth with all seed sizes and all fertilizer levels, especially the second and the third levels of fertilization, at both sites. The overview results showed that the (15 and 10 cm) depth and (75 and 150 kg P₂O₅. ha⁻¹) had generally positive effect on most plant growth characters.

Number of pods / plant:

Table (4) denotes that there is no significant differences in the number of pods / plant with different seeds size, this is in consistence with the results of Idris (2008) and Mekkei (2014), The depth (10 cm) gave the high number of pods / plant in both sites (10.44 and 9.48 pod) for Erbil and Mosul respectively. The fertilization levels (150 and 75 kg P₂O₅. ha⁻¹) also gave the highest number of pods / plant at both sites, this results in consistent with Issa (2009), Hashemabadi (2013), Huthily and al-Hassani (2014). The interaction between all sizes of seed sown in (10 cm) depth were significantly higher in number of pods / plant comparing with other interactions.

Table (3): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on pod length (cm).

Erbil location					
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	9.7 g-j	10.7 e-i	9.8 f-j	10.1 c
	10	11.3 de	12.8 bc	11.3 de	11.8 b
	15	13.3 a-c	14.4 a	13.9 a-c	13.9 a
Medium	5	9.4 hij	10.1 e-j	9.3 j	9.6 c
	10	10.9 e-g	12.5 cd	11.0 e-g	11.5 b
	15	13.6 a-c	14.3 ab	12.9 bc	13.6 a
Large	5	9.3 ij	10.7 e-h	9.7 g-j	9.9 c
	10	11.2 d-f	12.5 cd	11.3 de	11.7 b
	15	13.4 a-c	13.6 a-c	13.3 a-c	13.4 a
fertilizers mean		11.3 b	12.4 a	11.4 b	
Size		Size X fertilizers mean			Size mean
Small		11.4 c	12.6 a	11.7 bc	11.9 a
Medium		11.3 c	12.3 ab	11.1 c	11.5 a
Large		11.3 c	12.3 ab	11.4 c	11.7 a
Depth		Depth X fertilizers mean			Depth mean
5		9.5 d	10.5 c	9.6 d	9.8 c
10		11.1 c	12.6 b	11.2 c	11.7 b
15		13.4 a	14.1 a	13.4 a	13.6 a
Mosul location					
Small	5	7.3 fg	8.6 a-f	7.9 d-g	7.9 b
	10	7.9 d-g	8.3 c-g	7.9 d-g	8.0 b
	15	8.8 a-d	9.8 a	9.2 a-d	9.3 a
Medium	5	7.0 g	8.1 c-g	8.1 c-g	7.7 b
	10	7.9 c-g	8.1 c-g	8.1 c-g	8.0 b
	15	8.3 c-g	9.7 ab	9.2 a-d	9.1 a
Large	5	7.6 e-g	8.5 b-f	7.9 d-g	8.0 b
	10	8.3 c-g	8.0 c-g	7.9 c-g	8.1 b
	15	8.5 b-f	9.3 a-c	9.9 a	9.2 a
fertilizers mean		7.9 b	8.7 a	8.4 a	
Size		Size X fertilizers mean			Size mean
Small		8.0 bc	8.9 a	8.3 a-c	8.4 a
Medium		7.7 c	8.6 ab	8.4 a-c	8.3 a
Large		8.1 bc	8.6 ab	8.5 ab	8.4 a
Depth		Depth X fertilizers mean			Depth mean
5		7.3 c	8.4 b	7.9 b	7.9 b
10		8.0 b	8.1 b	8.0 b	8.0 b
15		8.5 b	9.6 a	9.4 a	9.2 a

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

In the interactions of seed sizes with fertilization, the large seeds with (75 and 150 kg P₂O₅. ha⁻¹) gave the highest number of pods/ plant at Erbil, and decreased significantly with (0 kg P₂O₅. ha⁻¹) at Mosul the highest number of pods / plant was recorded in small seeds with (150 kg P₂O₅. ha⁻¹) level. The lowest number of pods / plant resulted from the medium size seeds without fertilization, concerning of depth and fertilization, the second sown at (10cm) depth with all levels of fertilization, surpassed this character significantly at both locations. In the case of triple interaction it was noticed that the number of pods / plant increased at (10 cm) depth with all level fertilization, regardless of the seed sizes, this results show that (10 cm) depth and phosphate fertilization was superior comparing with other interaction.

Number of seeds / pod:

The data in table (5) shows no significant differences in the number of seeds / pods between seed sizes at both sites, similar results achieved by Idris (2008) and Mekkei (2014). The highest number of seeds / pod was observed at Erbil for the plants sown at (15 cm) depth (6.64 seeds / pod), which was not differ significantly from the depth (5 cm) as it gave (6.46 seeds / pod), while at Mosul site there is no differences in number of seeds / pod between different depths. The second level of fertilization at both sites surpassed significantly number of seeds / pod comparing with the other levels and gave 6.54 and 6.37 seed / pod at Erbil and Mosul respectively, this corresponds with Huthily and al-Hassani (2014); Sarkar et al (2017). The interaction of seed sizes and sowing depths was significantly higher for the three sizes at (5 and 15 cm) depth at Erbil, the results were resemble to Mosul, and this is in consistent with the results of Singh et al (2010). The highest number of seeds / pods achieved for the second fertilization level (75 kg P₂O₅. ha⁻¹) with all seed sizes at both sites. The highest number of seeds / pod was recorded at (15cm) depth with (75 kg P₂O₅. ha⁻¹) at Erbil. At Mosul the plants fertilized with (75 kg P₂O₅. ha⁻¹) at all depths gave the highest number of seeds / pod. The second order interaction gave highest number of seeds / pod for all seed sizes sown at (15 cm) depth and fertilized with (75 kg P₂O₅. ha⁻¹), while the no. seeds / pod was increased (7.13 seeds / pod) at Erbil location. While at Mosul the highest number of seeds / pod was obtained (5 cm) depth with medium seed size and (150 kg P₂O₅. ha⁻¹). In general it was noticed that flowering fertility was increased by adding super phosphate either in the second or third level of fertilization.

100 seed weight (gm).

Table (6) revealed to no significant differences in the 100 seeds weight (gm) between seed sizes at both sites, this is in consistent with Idris (2008). While 100 seed weight surpassed significantly at (15cm) depth comparing with other depths, the mean of 100 seed weight was (153.61gm) and (151.28g) at Erbil and Mosul respectively, these results are similar to that of Al-Anbari et al (2010). The two levels of fertilization (75 and 150 kg P₂O₅. ha⁻¹) have a positive significant effect on this characters comparing with (zero kg P₂O₅. ha⁻¹), even though there is no significant differences between the two levels. This is similar to Issa results (2009); Hashemabadi (2013); Huthily and al-Hassani (2014); Kubure et al (2016) and Sarkar et al (2017).

Table (4): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on number of pods /plants.

Erbil location					
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
size, depth and fertilizers					
Small	5	8.5 hi	9.2 e-g	9.0 e-h	8.9 c
	10	10.3 a	10.4 a	10.2 ab	10.3 a
	15	9.1 e-h	9.4 d-g	9.5 c-f	9.3 b
Medium	5	8.8 f-i	8.7 g-i	9.3 d-g	8.9 c
	10	10.5 a	10.1 a-d	10.7 a	10.4 a
	15	9.6 b-e	9.6 b-e	9.4 d-g	9.5 b
Large	5	8.2 i	9.2 e-g	9.2 e-h	8.8 c
	10	10.2 a-c	10.7 a	10.6 a	10.5 a
	15	9.0 e-h	9.5 b-f	9.5 b-f	9.3 b
Fertilizers mean		9.3 b	9.6 a	9.7 a	
Size		Size X fertilizers mean			Size mean
Small		9.3 bc	9.7 ab	9.5 ab	9.5 a
Medium		9.6 ab	9.4 a-c	9.8 a	9.6 a
Large		9.1 c	9.8 a	9.7 a	9.6 a
Depth		Depth X fertilizers mean			Depth mean
5		8.5 d	9.0 c	9.1 bc	8.9 c
10		10.3 a	10.4 a	10.5 a	10.4 a
15		9.2 bc	9.5 b	9.5 b	9.4 b
Mosul location					
Small	5	7.8 f-h	8.3 b-g	8.7 a-f	8.2 b
	10	9.4 a-d	9.1 a-f	9.6 ab	9.3 a
	15	8.1 d-g	8.6 a-f	8.7 a-f	8.5 b
Medium	5	6.9 h	8.1 d-g	8.9 a-f	7.9 b
	10	9.1 a-e	9.4 a-d	9.6 ab	9.3 a
	15	8.8 a-f	8.6 a-f	8.2 d-g	8.5 b
Large	5	7.2 gh	8.8 a-f	8.4 b-g	8.1 b
	10	9.8 a	9.5 a-c	9.6 ab	9.6 a
	15	8.5 a-f	8.7 a-f	7.9 e-h	8.3 b
fertilizers mean		8.4 b	8.8 a	8.8 a	
Size		Size X fertilizers mean			Size mean
Small		8.4 ab	8.6 ab	9.0 a	8.7 a
Medium		8.2 b	8.7 ab	8.9 ab	8.6 a
Large		8.5 ab	9.0 a	8.6 a	8.7 a
Depth		Depth X fertilizers mean			Depth mean
5		7.3 c	8.4 b	8.7 b	8.1 b
10		9.4 a	9.3 a	9.6 a	9.4 a
15		8.5 b	8.6 b	8.2 b	8.4 b

Means followed by similar letters within factors or their interactions are not significantl different according to DMRT (1955), at 5% probability.

All seed sizes sowing at (15cm) surpassed significantly depths in 100 seed weight at both location. All sizes of seed fertilized with (75 and 150 kg P₂O₅. ha⁻¹) also surpassed for 100 seed weight comparing to (0 kg P₂O₅. ha⁻¹) at Erbil location, the results at Mosul were almost similar. The 100 seed weight surpassed significantly at (15 cm) depth interfered with (zero and 75 kg P₂O₅. ha⁻¹) at Erbil location and with (0, 75 and 150 kg P₂O₅. ha⁻¹) at Mosul location. For the second order interaction, 100 seeds weight surpassed significantly at (15 cm) depth with all seed sizes and with all fertilization levels at both site.

Seed yield (gm /plant):

Table (7) revealed to no significant differences for seed yield regarding dissimilarity of seed sizes at both sites. This result is consistent with Idris (2008). The sowing depth (15 cm) gave significantly higher seed yield (61.7 and 61.5 gm / plant) for Erbil and Mosul respectively, also the second and the third phosphate fertilization levels enhanced significantly this trait (58.6, 53.7 gm / plant) for Erbil and (58.2, 51.8 gm) for Mosul respectively, these results are in agreement with those of Issa (2009); Hashemabadi (2013); Huthily and al-Hassani (2014); Kubure et al (2016) and Sarkar et al (2017). The sowing depth at (15 cm) showed a significant increase in seed yield with all seed sizes. Also all sizes of seed surpassed significantly in seed yield by adding (75 and or 150 kg P₂O₅ ha⁻¹) comparing with the other interaction at both locations. Seed yield (gm /plant) surpassed significantly by sowing at (15 cm) depth with all levels of fertilization, at (10cm) depth with (75 and 150 kg P₂O₅ ha⁻¹) at Erbil. At Mosul the superiority was obvious when the seeds sowing at depth (15 cm) with all levels of fertilization. In triple interaction the highest value of the seed yield was recorded at all seed sizes sown at (15 cm) depth for all levels of fertilization at both site. The significant increase in seed yield due to the significant effect on yield components i.e. (number of pods / plant, number of seeds / pod and 100 seeds weight) (tables 4, 5 and 6).

Biological yield (gm /plant):

The biological yield was not affected significantly by the variation in seed sizes at both locations, (table 8), this is consistent with Mekkei (2014). The biological yield raised significantly at (5 cm) depth to (156.7 and 153.0 gm / plant) for Erbil and Mosul respectively. The third and second level of phosphate surpassed significantly the biological yield (157.5, 154.2 gm /plant) for third level and (154.6, 152.0 gm /plant) for second level at Erbil and Mosul respectively. These results agree with Kuure et al. (2016), The interaction between the two depths (5 and 15 cm) with all seed sizes was significantly superior in biological yield. Also all sizes of seeds with the second and third fertilization levels surpassed significantly the biological yield and exceeded the rest interactions. The biological yield increased significantly at (5cm) depth with (150 kg P₂O₅ ha⁻¹) at both sites. The second order interaction at all sizes of seeds planted at depth (5cm), and fertilized with (150 kg P₂O₅.ha⁻¹) surpassed significantly biological yield comparing with the rest treatment combinations.

Table (5) Effect of seed size, sowing depth, phosphorus fertilization and their interaction on number of seeds / pods.

		Erbil location			
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	5.9 e-i	6.9 ab	6.6 a-e	6.5 a
	10	5.1 j	5.6 g-j	5.4 hij	5.4 b
	15	6.1 f-h	7.1 a	6.1 d-h	6.4 a
Medium	5	5.6 g-j	7.0 ab	6.6 a-e	6.4 a
	10	5.8 f-j	5.5 g-j	5.8 f-j	5.7 b
	15	6.7 a-d	7.1 a	6.4 b-f	6.7 a
Large	5	5.8 g-j	6.8 a-c	6.6 a-e	6.4 a
	10	5.2 ij	5.5 g-j	5.5 g-j	5.4 b
	15	6.2 c-g	7.1 a	6.7 a-d	6.6 a
fertilizers mean		5.8 c	6.5 a	6.2 b	
Size		Size X fertilizers mean			Size mean
Small		5.7 c	6.5 a	6.0 bc	6.1 a
Medium		6.0 bc	6.5 a	6.3 ab	6.3 a
Large		5.7 c	6.5 a	6.2 ab	6.1 a
Depth		Depth X fertilizers mean			Depth mean
5		5.8 d	6.9 ab	6.6 bc	6.4 a
10		5.4 e	5.5 de	5.6 de	5.5 b
15		6.3 c	7.1 a	6.4 c	6.6 a
Mosul location					
Small	5	5.4 f-i	6.4 a-e	6.4 a-d	6.1 ab
	10	5.4 f-i	6.2 a-h	5.2 hi	5.6 b
	15	6.0 b-i	6.6 ab	5.4 e-i	6.0 ab
Medium	5	5.0 i	6.5 a-c	7.1 a	6.2 a
	10	6.1 a-h	6.2 a-g	5.1 i	5.8 ab
	15	5.5 d-i	6.1 a-h	5.8 b-i	5.8 ab
Large	5	5.5 d-i	6.3 a-f	6.1 a-h	6.0 ab
	10	6.6 ab	6.6 ab	5.3 g-i	6.2 a
	15	5.6 c-i	6.1 a-h	6.2 a-h	5.9 ab
fertilizers mean		5.7 b	6.3 a	5.8 b	
Size		Size X fertilizers mean			Size mean
Small		5.6 c	6.4 a	5.7 c	5.9 a
Medium		5.5 c	5.5 ab	6.0 a-c	5.9 a
Large		5.9 a-c	6.3 ab	5.9 bc	6.0 a
Depth		Depth X fertilizers mean			Depth mean
5		5.3 cd	6.4 a	6.5 a	6.1 a
10		6.0 ab	6.3 a	5.2 d	5.8 a
15		5.7 b-d	6.3 a	5.8 bc	5.9 a

Means followed by similar letters within factors or their interactions are not significantl different according to DMRT (1955), at 5% probability.

Table (6): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on 100 seed weight (gm).

Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X depth mean
		0	75	150	
size, depth and fertilizers					
Small	5	77.7 h	92.8 g	96.4 g	88.9 c
	10	113.9 f	144.1 e	145.7 de	134.6 b
	15	157.9 a	154.1 a-c	151.2 a-e	154.4 a
Medium	5	80.2 h	93.1 g	96.7 g	90.0 c
	10	115.7 f	144.1 e	148.7 b-e	136.2 b
	15	155.4 ab	152.9 a-d	150.9 a-e	153.1 a
Large	5	80.1 h	93.6 g	97.9 g	90.6 c
	10	112.6 f	143.9 e	147.0 c-e	134.5 b
	15	153.9 a-c	154.6 a-c	151.3 a-e	153.3 a
fertilizers mean		116.4 b	130.3 a	131.7 a	
Size		Size X fertilizers mean			Size mean
Small		116.5 b	130.3 a	131.1 a	126.0 a
Medium		117.1 b	130.0 a	132.1 a	126.4 a
Large		115.5 b	130.7 a	132.1 a	126.1 a
Depth		Depth X fertilizers mean			Depth mean
5		79.3 g	93.1 f	97.0 f	89.8 c
10		114.1 e	144.0 d	147.1 cd	135.1 b
15		155.7 a	153.9 ab	151.1 bc	153.6 a
Mosul location					
Small	5	74.4 f	84.6 e	85.2 e	81.4 d
	10	102.8 cd	106.1 bc	104.2 cd	104.4 bc
	15	151.7 a	152.7 a	150.7 a	151.7 a
Medium	5	74.2 f	85.7 e	84.5 e	81.5 d
	10	103.4 cd	108.1 b	105.0 b-d	105.5 b
	15	151.2 a	151.7 a	150.5 a	151.1 a
Large	5	74.1 f	83.9 e	85.6 e	81.2 d
	10	102.0 d	103.6 cd	105.3 b-d	103.6 c
	15	151.5 a	151.0 a	150.3 a	150.9 a
fertilizers mean		109.5 b	114.1 a	113.5 a	
Size		Size X fertilizers mean			Size mean
Small		109.6 c	114.5 ab	113.4 ab	112.5 a
Medium		109.6 c	115.2 a	113.4 ab	112.7 a
Large		109.2 c	112.8 b	113.7 ab	111.9 a
Depth		Depth X fertilizers mean			Depth mean
5		74.2 e	84.7 d	85.1 d	81.3 c
10		102.7 c	105.9 b	104.8 b	104.5 b
15		151.4 a	151.8 a	150.5 a	151.2 a

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

Table (7) Effect of seed size, sowing depth, phosphorus fertilization and their interaction on seed yield (gm /Plant).

Erbil location					
Seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	37.4 c	51.0 b	50.6 b	46.3 d
	10	53.2 b	63.5 a	61.1 a	59.3 c
	15	61.5 a	62.5 a	62.1 a	62.0 a
Medium	5	38.4 c	51.0 b	51.5 b	46.9 d
	10	54.4 b	62.1 a	63.4 a	60.0 a-c
	15	61.9 a	61.6 a	61.3 a	61.6 ab
Large	5	37.3 c	51.0 b	50.8 b	46.4 d
	10	54.1 b	62.6 a	62.1 a	59.6 bc
	15	61.0 a	61.8 a	61.2 a	61.3 a-c
fertilizers mean		51.0 b	58.6 a	58.2 a	
Size		Size X fertilizers mean			Size mean
Small		50.7 b	59.030 a	58.002 a	55.9341 a
Medium		51.5 b	58.278 a	58.801 a	56.2219 a
Large		50.8 b	58.513 a	58.083 a	55.8233 a
Depth		Depth X fertilizers mean			Depth mean
5		37.7 d	51.0 c	51.0 c	46.6 c
10		53.9 b	62.7 a	62.2 a	59.6 b
15		37.7 d	62.0 a	61.5 a	61.7 a
Mosul location					
Small	5	28.9 k	40.3 j	50.6 b	37.9 c
	10	51.5 f-i	56.3 b-g	50.0 g-i	52.6 b
	15	62.0 ab	61.4 a-c	60.9 a-d	61.4 a
Medium	5	23.8 k	40.8 j	46.5 hij	37.0 c
	10	53.4 d-h	57.6 a-e	49.7 g-i	53.5 b
	15	61.8 ab	62.3 ab	60.9 a-d	61.6 a
Large	5	27.1 k	41.4 j	42.2 j	36.9 c
	10	54.1 c-g	59.0 a-e	52.2 e-h	55.1 b
	15	60.3 a-d	64.2 a	59.8 a-d	61.4 a
fertilizers mean		47.0 b	53.7 a	51.8 a	
Size		Size X fertilizers mean			Size mean
Small		47.5 b	52.6 a	51.8 a	50.6 a
Medium		46.3 b	53.5 a	52.3 a	50.7 a
Large		47.2 b	54.9 a	51.4 a	51.1 a
Depth		Depth X fertilizers mean			Depth mean
5		26.6 e	40.8 d	44.4 d	37.2 c
10		53.0 c	57.6 b	50.6 c	53.7 b
15		61.3 ab	62.6 a	60.5 ab	61.5 a

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

Harvest index (HI) (%).

The data in table (9) refer to no significant effect of seed sizes in (HI) at both site. This result is consistent with Mekkei (2014). Sowing at (10 cm) depth gave higher (HI) at Erbil (41.55%) in consistent, while sowing at (15 cm) depth gave the higher (HI) at Mosul (41.10%). The (HI) surpassed with the second and third level of (P_2O_5) at Erbil and for the second level of fertilization at Mosul. The interaction between seed size and sowing depths showed that small, medium and large seeds were significantly surpassed in (10 and 15 cm) depth at Erbil, while (15 cm) depth with all seed sizes was best at Mosul. All sizes of seeds fertilized with (75 and 150 kg P_2O_5 ha⁻¹) exceeded other interactions for this trait. The highest (HI) was obtained from (10 cm) depth with the second and third fertilization levels at Erbil i.e. (75 and 150 kg P_2O_5 ha⁻¹), while at Mosul the (15 cm) depth with all levels of fertilization, and (10 cm) depth with (75 kg P_2O_5 ha⁻¹) surpassed the remaining interaction this trait. The second order interaction was significant for (HI) at both site. In general, the (10 cm) depth with (75 and 150 kg P_2O_5 ha⁻¹) and with all seed sizes significantly than superior the rest interactions for (HI) at Erbil, while at Mosul the (15cm) depth with all seed sizes and all fertilization levels was greater. The highest (HI) was recorded for the medium seed grown at (15 cm) depth without fertilization (42.35%).

We can conclude that there is no obvious effect of seed sizes on most studied traits, while the (10 and 15cm) depths positively affect most yield traits, and most traits were positively affected while increasing the amount of fertilizer, especially at (10 and 15 cm) depths as the moisture is more available than in these depths of the (5cm) depth.

Table (8): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on biological yield (gm /plant).

Erbil location					
seed size	Sowing depth (cm)	phosphorus fertilizers rate			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	129.0 f	164.5 c	179.1 a	157.6 a
	10	144.3 de	143.9 de	141.7 e	143.3 b
	15	151.6 de	153.7 d	154.2 d	153.2 a
Medium	5	126.5 f	167.5 bc	176.3 ab	156.8 a
	10	143.7 de	143.7 de	143.3 de	143.6 b
	15	150.9 de	153.4 d	152.0 de	152.1 a
Large	5	125.1 f	167.2 bc	174.7 ab	155.7 a
	10	144.5 de	143.5 de	143.6 de	143.9 b
	15	151.0 de	153.9 d	152.5 de	152.5 a
fertilizers mean		140.7 b	154.6 a	157.5 a	
Size		Size X fertilizers mean			Size mean
Small		141.6 b	154.1 a	158.3 a	151.3 a
Medium		140.4 b	154.9 a	157.2 a	150.8 a
Large		140.2 b	154.9 a	156.9 a	150.7 a
Depth		Depth X fertilizers mean			Depth mean
5		126.9 e	166.4 b	176.7 a	156.7 a
10		144.2 d	143.7 d	142.8 d	143.6 c
15		151.2 c	153.7 c	152.9 c	152.6 b
Mosul location					
Small	5	121.5 g	164.4 ab	170.2 ab	152.0 a
	10	140.9 ef	141.2 d-f	141.7 c-f	141.1 b
	15	146.4 c-f	152.2 c	150.7 c-e	149.7 a
Medium	5	123.4 g	164.2 ab	173.3 a	153.6 a
	10	140.0 ef	140.5 ef	140.5 ef	140.4 b
	15	145.9 c-f	150.3 c-f	149.1 c-f	148.5 a
Large	5	125.8 g	162.5 b	171.6 ab	153.3 a
	10	141.2 d-f	141.7 c-f	139.4 f	140.7 b
	15	149.8 c-f	151.0 c-e	151.9 cd	150.9 a
Fertilizers mean		137.2 b	152.0 a	154.2 a	
Size		Size X fertilizers mean			Size mean
Small		136.2 b	152.6 a	154.1 a	147.679 a
Medium		136.4 b	151.7 a	154.3 a	147.532 a
Large		138.9 b	151.7 a	154.3 a	148.351 a
Depth		Depth X fertilizers mean			Depth mean
5		123.5 e	163.7 b	171.7 a	153.0 a
10		140.7 d	141.1 d	140.4 d	140.7 c
15		147.4 c	151.2 c	150.6 c	149.7 b

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

Table (9): Effect of seed size, sowing depth, phosphorus fertilization and their interaction on Harvest index (%).

		Erbil location			
Seed size	Sowing depth (cm)	phosphorus fertilization			Size X Depth mean
		0	75	150	
		size, depth and fertilizers			
Small	5	28.9 h	31.0 h	28.4 h	29.4 b
	10	36.9 g	44.1 a	43.1 a-d	41.3 a
	15	40.6 c-e	40.6 c-e	40.3 c-f	40.5 a
Medium	5	30.2 h	30.4 h	29.3 h	30.0 b
	10	37.8 e-g	43.2-d	44.2 a	41.7 a
	15	41.0 b-d	40.1 d-f	40.3 c-f	40.5 a
Large	5	29.7 h	30.5 h	29.2 h	29.8 b
	10	37.4 fg	43.6 ab	43.3 a-c	41.4 a
	15	40.4 c-f	40.1 d-f	40.1 d-f	40.2 a
fertilizers mean		35.9 b	38.2 a	37.6 a	
Size		Size X fertilizers mean			Size mean
Small		35.4 d	38.6 a	37.3 a-c	37.1 a
Medium		36.3 b-d	37.9 ab	37.9 ab	37.4 a
Large		35.8 cd	38.1 a	37.5 ab	37.1 a
Depth		Depth X fertilizers mean			Depth mean
5		29.6 de	30.6 d	28.9 e	29.7 c
10		37.4 c	43.6 a	43.5 a	41.5 a
15		40.6 b	40.3 b	40.2 b	40.4 b
		Mosul location			
Small	5	23.5 d-f	24.5 de	26.0 de	24.7 d
	10	36.5 bc	39.8 a-c	35.4 c	37.2 c
	15	42.3 a	40.3 a-c	40.4 a-c	41.0 a
Medium	5	19.2 f	24.9 de	27.0 d	23.7 d
	10	38.1 a-c	40.9 ab	35.3 c	38.1 bc
	15	42.3 a	41.4 ab	40.8 ab	41.5 a
Large	5	21.5 ef	25.5 de	24.6 de	23.9 d
	10	38.3 a-c	41.6 ab	37.5 a-c	39.1 a-c
	15	40.2 a-c	42.5 a	39.3 a-c	40.7 ab
fertilizers mean		33.6 b	35.7 a	34.0 b	
Size		Size X fertilizers mean			Size mean
Small		34.1 ab	34.9 ab	33.9 ab	34.5 a
Medium		33.2 b	35.7 ab	34.3 ab	34.4 a
Large		33.3 b	36.5 a	33.8 ab	34.6 a
Depth		Depth X fertilizers mean			Depth mean
5		21.4 e	25.0 d	25.9 d	24.1 c
10		37.7 bc	40.8 a	36.1 c	38.2 b
15		41.6 a	41.4 a	40.2 ab	41.1 a

Means followed by similar letters within factors or their interactions are not significantly different according to DMRT (1955), at 5% probability.

تأثير أحجام البذور وأعماق الزراعة ومستويات من التسميد الفوسفاتي في صفات الحاصل ومكوناته للباقلء المحلية.

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الخلاصة

نفذت تجربة حقلية في موقعي (اربيل والموصل) للموسم الشتوي 2017-2018. لدراسة تأثير ثلاثة أحجام مختلفة من بذور الباقلاء المحلية (صغيرة ومتوسطة وكبيرة) مزروعة بثلاثة أعماق (5 ، 10 ، 15سم) وباستخدام ثلاثة مستويات من التسميد الفوسفاتي (صفر و 75 و 150 كغم P₂O₅ /هـ) في بعض صفات الحاصل. استخدم تصميم القطاعات العشوائية الكاملة (R.C.B.D) واختبار دنكن متعدد المدى للمقارنة بين المتوسطات. أظهرت النتائج عدم وجود تأثير معنوي لأحجام البذور في معظم الصفات المدروسة، فيما تفوق طول القرنة (13.6 ، 9.2 سم) ووزن (100) بذرة (153.6 ، 151.2 غم) وحاصل البذور (61.7 ، 61.5 غم) عند العمق (15 سم) في الموقعين. كما ازداد عدد القرينات / النبات ووزن (100) بذرة وحاصل البذور والحاصل الحيوي معنوياً عند مستوى التسميد الثاني والثالث في الموقعين. وتفاوتت أطوال القرينات (12.4 و 8.7 سم) وعدد البذور / قرنة (6.5 و 6.3 بذرة / قرنة) ودليل الحصاد (38.1 و 35.7 %) عند المستوى الثاني من التسميد في الموقعين. أظهرت معظم التداخلات الثنائية والثلاثية فروقاً معنوية بين معظم الصفات المدروسة.

الكلمات المفتاحية: الباقلاء، الحاصل، أعماق الزراعة، التسميد الفوسفاتي.

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