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FABA BEAN (*VICIA FABA* L.) PHENOLOGY AND PERFORMANCE IN RESPONSE TO ITS SEED SIZE CLASS AND PLANTING DEPTH

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Abstract

A field experiment was conducted at Crop Research Programme, Pusa, Bihar (25.98° N Latitude, 85.67° E Longitude) during *rabi* seasons of 2006-07 and 2007-08 to ascertain the response of faba bean (*Vicia faba* L.) for alteration of its ambient environment leading to certain modification in the crop phenology, yield attributes and seed yield. Data were recorded on growth development for phenology and yield for economic performance. Pooled analysis was carried to know the judicious performance of faba bean by and large under normal condition averaged by pooling of two year results. Maximum and minimum time (days) taken to complete 50 per cent germination by extra bold seed group sown at shallow depth (6.5 days) and small seed class sown at maximum depth took 11.5 days. Shallow depth of seeding of medium seed size class produced tallest plant (88.7cm height) whereas minimum (79.4 cm) was noticed in case of small seed class and depth of seeding. Medium seed size class produced maximum number of productive branches (12.3) which proved superior over other seed size class. Extra bold seed size class in combination of shallow depth of sowing flowered in the quickest time (57.5 days). Maximum number (54.2) of pod per plant was noticed with small seed size class planted at shallow depth and corresponding minimum was 32.2 with extra bold seed size classes sown at maximum depth. Maximum pod length (4.32cm) was recorded with small seed size class which also produced maximum grain per pod (4.07) and decreased significantly with increase in boldness in seed. Maximum seed yield (40.6 g per plant) was obtained when medium size seed was sown at shallow depth and minimum (34.9 g per plant) with extra bold seed when sown at maximum depth. Maximum seed yield (3715.5 kg) of faba bean was recorded in case of medium seed size class sown at medium depth (8cm) whereas corresponding minimum yield (3354.9 kg) was recorded with extra bold seed sown at deeper depth.

Key words : Faba bean, Growth and development, Seeding depth, Seed size, Seed yield.

1. Introduction

The faba bean (*Vicia faba* L.) also known as broad bean, horse bean, field bean, Windsor bean in various country, in Hindi it is popularly famous as Kala Matar and Bakala. The

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authentic geographical origin of this crop is still unknown, although Central Asia and The Mediterranean region have been proposed as possible centers. According to United Nation, Food and Agricultural Organization [FAO (2009)], globally faba bean (*Vicia faba* L.) is third most important feed grain legume after soybean (*Glycine max*) and pea (*Pisum sativum* L.) with a total production of 4.87 MT and harvested area of 2.63 Mha. China is currently the world leading producer with 60 per cent of the total. Other important producers are northern Europe. The Mediterranean, Ethiopia, Central and East Asia and Latin America. Faba bean is cultivated in different States in considerable area particularly in the State of Uttar Pradesh, Bihar, Punjab, Haryana, Jammu Kashmir, Rajasthan, Karnataka and Madhya Pradesh. The centre of origin of faba bean is Mediterranean region, Egypt, North America and North-West Asia from where it was first introduced in Europe, China, Japan and then India. In India, faba bean was introduced most probably in medieval times during the Sultanic period (1206-1555) because the oldest records by Dara Shikoh (c. 1650), the Nuskha Dar Fanni-Falahat mention the practice of cultivation and soil enhancing properties of faba bean Razia Akbar (2000).

It is rich source of lysine rich protein (20-30%) depending upon cultivars and agro-climatic conditions under which faba bean grown. They are also fairly high in β- carotene. thiamine, riboflavin, iron and good source of dietary fiber. Seeds are roasted and eaten like groundnut, eaten as vegetable also grown for fodder and hay purpose. Faba bean can cause problem for small percentage of people, *favism* is an inherited condition in which a person lacks an enzyme called glucose-6-phosphatage dehydrogenase (*G6PD*). It also causes gas and abdominal pain due to complex carbohydrates known as oligosaccharides. Potential use of Faba bean is in the treatment of Parkinson's disease being a good source of *levadopa* a precursor of dopamine, as a result of Parkinson's disease affected persons unable to synthesize dopamine which regulate motor cells. Being such important crop, it is still marginalized in India. In India, it is basically an underutilized leguminous crop grown in localized pockets on marginal and poor land without any proper care. It is hardy crop and grown as sole, mixed or intercrop. This crop is basically grown on residual moisture without any assured water supply system in general except in kitchen gardens.

Faba bean (*Vicia faba* L.) is cool winter *rabi* season crops in India that can tolerate wide range of climatic adversity, soil type and pH, but prefers well drained fertile loamy soil with one or two irrigations. In Bihar, particularly in northern districts which is frequently affected by flood (Samastipur, Muzaffarpur, Sitamarhi, Darbhanga to name few), despite of good coverage of this crop, very limited work has been done on its agronomic management and varietals improvement. Hence, most of the cultivars are local one or exotic introduction adopted well in this region and cultivating without any due care. Constraints that contribute to low productivity of faba bean include improper cultural practices and lack of good quality planting material (seeds), leading to sub optimum plant stand resulting poor yield. In order to improve the production and productivity of faba bean crop in traditional areas of Bihar, participatory research appraisal (PRA) has been conducted to workout researchable issue related to this crop. On the basis of participatory research appraisal (PRA) conducted for acceleration of productivity of this economically important crop of this region revealed that

researchable agronomical constraints may be many but seed size and seeding depth are the important non money agronomic issues that's needs to be undertake ou priority. In order to optimize the production potential of this crop a research trail has been conducted on two non-money agronomic aspects (1) seed size and (2) seeding depth to ascertain the role of these two factors determining the growth, yield component and finally yield of faba bean under Bihar condition.

2. Materials and Methods

The field experiment was conducted at Crop Research Programme, Pusa, Bihar Pusa (25.98° N Latitude, 85.67° E Longitude) during *rabi* seasons of 2006-07 and 2007-08. The soil of experimental site was sandy loam in texture, calcareous in nature and slightly alkaline in reaction. The inherent nutrient supplying capacity of the soil was in the medium range in respect of available nitrogen, phosphorus and potassium as well. The experiment consists of four seed sizes and three seeding depths. The seeds were sorted out into four sizes from the core collection made from the farmer's field/ threshing floors from northern district of Bihar during participatory research appraisal (PRA). These are mainly local cultivars being cultivated since long. The four seed size classes is based on their boldness measured by their 100 seed weight and classes are made small (15.6g), medium (26.5g). bold (33.4g) and extra bold (44.5g). These classes are denominated as S, M, B and EB respectively. Similarly, seeding depth was kept at 4, 8 and 12 cm and designated as D1, D2 and D3 respectively. The four seed size classes and the three seeding depths were combined together consisting twelve treatments which were organized in factorial experiment in completely randomized design (CRD) with four replications. Sowing operation was carried out during first week of November during both the years. Seeds were sown on well prepared flat bed at 30 cm row to row and 20 cm plant to plant spacing respectively, putting three seeds in each hole. To ensure the plant seeds at desired depth of 4, 8 or 12cm holes are made. After fortnight of sowing operation, plant were thinned out keeping two healthy plants per hole to maintain optimum plant population. The size of plots was 5m × 4m. Standard packages of practice were adopted as in case of legume crops. Crop was fertilized with NPK @ 20:50:40 kg/ha, respectively. Three numbers of irrigation was siven (i) at grand growth phase (ii) pre flowering stages and (iii) pod filling stages during both the seasons. One hand weeding was carried out at initial stages of crop growth. No major incidence of pests and disease were noticed during the course of experimentation. Germination of seeds were satisfactory during the both the seasons, hence crop stand was normal. Weather condition of Pusa, Bihar was within the range during the experimentation period of both seasons. Data were recorded on growth, yield attributes and yield and converted kg/ha. Observation on days to 50% flowering was recorded to know the effects of genotypes and environmental condition being a polygenic trait. Plant height (cm), no. of productive branch per plant, no of pod per plants, no of seed per pod, seed yield (g) per plant, 100 seed weight and seed yield per hectare were recorded and computed at harvest. Observations were recorded for five sampled plants and averaged. Pooled analysis was carried out as per normal procedures. The analysis of variance was carried out for the results and treatment means were separated using the least significant difference (LSD) according to the procedure described by Gomez and Gomez (1984).

3. Results and Discussion

Days taken to 50 per cent germination

Faba bean requires a cool season for best development. It is grown as a winter annual in warm temperate and subtropical areas. Germination is first step towards the activation of life cycle, which takes place under favourable agro climatic conditions. Time taken by plant to germinate is governed by depth of seeding, size of seed (reserve food material). Successful germination is based on size of seed (reserve food material) and length of plumose and coleoptiles of particular crops. Being a legume faba bean having a robust tap root with profusely branched secondary roots. Perusal of data presented in Figure 1 confirms that with each increase in depth of seeding delayed the germination by time taking more time to emerge. Medium depth of sowing takes (8.5day) significantly more (7.8 days) and less (9.5 days) time than shallow and deep depth of sowing respectively. Boldness of seed had direct and positive bearing on early emergence. Extra bold seed size class have taken minimum duration to germinate (7.2 days) whereas maximum was taken by small seeded group (10.5 days). Medium size seed class (M) taken (8.7 days) significantly minimum and maximum time to 50 per cent germination over small seeded group (10.5 days) and bold (8.0 days) and extra bold seed size class (7.2 days), respectively. The interaction between two factors was also recorded for days taken to fifty per cent germination. Small seeded seed size class took significantly minimum time (9.5 days) to germinate when sown at shallow depth (SDI) over deep sowing (11.5 days). The same trend was noticed for all the seed size class (Fig. 1). Quickest and slowest to complete 50 per cent germination by extra bold seeded group sown at shallow depth (6.5 days) and small seeded class (S) sown at maximum depth (12 cm) to the extent of 11.5 days. This may be due to less time taken by coleoptiles to emerge and stored energy in the seed cotyledons. These results were in conformity with Abdel Latif (2008), Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

Plant height (cm)

Height of faba bean plant is largely governed by its genetic makeup and their growing environment. Faba bean employs a high degree of plasticity. Shallows depth of seeding (4cm) recorded significantly taller plant in comparison to deep seeding (12cm). Seed size class and sowing dates both have significant effects on plant height. Medium seed size class produced tallest plant (86.5cm), significantly superior over small (S) and extra bold (EB), whereas smallest plants were recorded in case of small seed size class. The significant interaction among the treatment combination (seeding depth and seed size class) was also recorded. Maximum plant height (88.7cm) was noticed when medium size seed class was sown at shallow depth, whereas minimum (79.4cm) was noticed in case of small seed class and deeper depth of seeding. Shallow depth and medium seed class combination produced tallest plant (88.7cm) than small seed class sown at any depth of sowing and extra bold seed class (EB) sown at 8 cm and 12 cm depth (Fig. 2). The same conclusion was reached by Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

Productive branch per plant (number)

Number of the pod bearing branched known as productive branches is one of the yield attributing traits. Depth of seeding had significantly influenced the productive branch per

Table 1 :Effect of seed size class and depth of sowing on days taken to 50 per cent germination.

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	9.5	10.5	11.5	10.5
Medium (M)	8	8.5	9.5	8.7
Bold (B)	7	8	9	8.0
Extra bold (EB)	6.5	7	8	7.2
Mean	7.8	8.5	9.5	

CD (Seed Size) at 5% = 0.5*
CD (Seeding Depth) at 5% = 0.6*
CD (Seed Size × Seeding Depth) at 5% = 1.2*
CV (%) = 18.5

Table 2 :Effect of seed size class and depth of sowing on plant height (cm).

Treatments	Seeding depth			
Seed size Class	D1	D2	D3	Mean
Small (S)	83.4	81.9	79.4	81.6
Medium (M)	88.7	86.1	84.8	86.5
Bold (B)	85	85.4	83.8	84.7
Extra bold (EB)	84.9	83.3	82.3	83.5
Mean	85.5	84.2	82.6	

CV (%) = 14.1
CD (Seed Size) at 5% = 2.8*
CD (Seeding Depth) at 5% = 2.5
CD (Seed Size × Seeding Depth) at 5% = 5.0

Table 3 :Effect of seed size class and depth of sowing on numbers of productive branch/plant.

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	10.9	10.3	10.1	10.4
Medium (M)	12.8	12.1	12	12.3
Bold (B)	12.2	11.7	11.2	11.7
Extra bold (EB)	11.9	10.7	10.8	11.1
Mean	12.0	11.2	11.0	

CD (Seed Size) at 5% = 2.6*
CD (Seeding Depth) at 5% = 0.5
CD (Seed Size × Seeding Depth) at 5% = 1.0
CV (%) = 15.1

Table 4 :Effect of seed size class and depth of sowing on days to first flowering.

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	61	62.5	63.5	62.3
Medium (M)	60	61.2	62.5	61.2
Bold (B)	58.5	59.7	60.7	59.6
Extra bold (EB)	57.5	58	58.5	58.0
Mean	59.3	60.4	61.3	

CD (Seed Size) at 5% = 1.3*
CD (Seeding Depth) at 5% = 1.1
CD (Seed Size × Seeding Depth) at 5% = 2.2
CV (%) = 12.5

plant. Shallow depth of seeding (4 cm) produced significantly higher productive branch (12) over other two studied depth of sowing under present investigation. There was no significant difference among two other tested depth of sowing in respect to productive branch per plant, prod ceded 11.2 and 11 respectively (Fig. 3). Seed size class had also influence the productive branch. Medium (M) size seed class produced maximum number of productive branches (12.3), which is proved superior over other tested seed size class. Similar results were reported by Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

Days taken to first flowering (anthesis)

Being a leguminous crop, indeterminate growth habit is a major genetic feature which provides unique opportunity to plant to after certain period of time of vegetative growth plants start simultaneously both the activity *i.e.*, vegetative and reproductive phase. Early

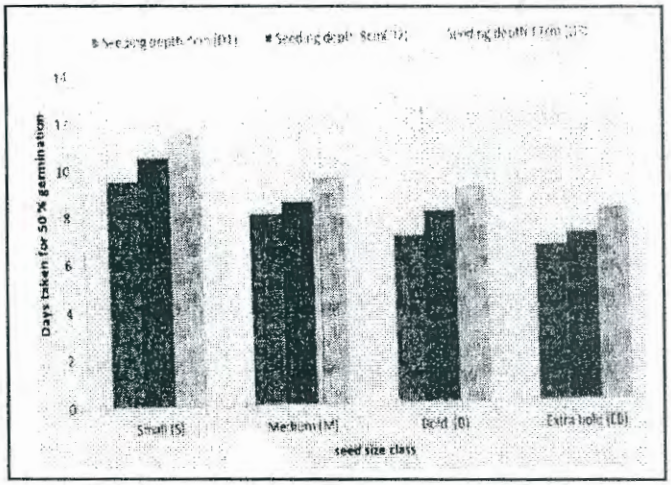

Fig. 1 : Effect of seed size class and depth of sowing on days taken to 50 per cent germination.

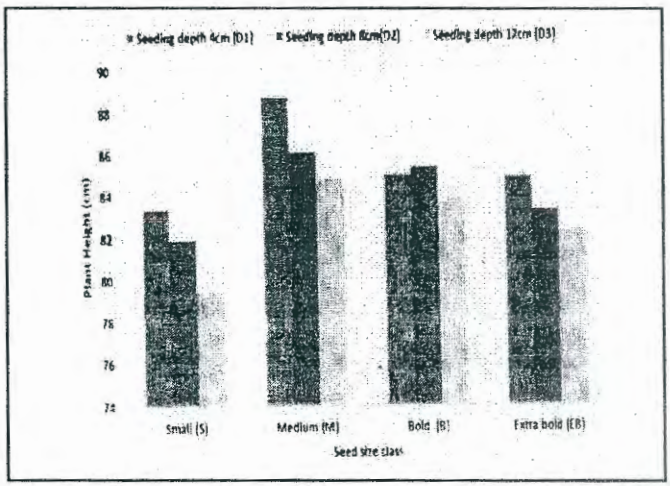

Fig. 2 : Effect of seed size class and depth of sowing on plant height (cm).

onset of reproductive phase which start with flowering, provide extra time for economic produce (seed formation). In the light of above studies on days taken to first flowering (anthesis) was undertaken for faba bean. Perusal of data revealed that with the increasing depth of seeding the days to onset of first flowering prolonged. Shallow depth of seeding (D1) takes significantly minimum time (59.3 days) over other two tested depth of seeding. Seed size class had also significant influence on flowering of faba bean (Fig. 4). Extra bold seed size class (EB) produced first flower in earliest time (58 days) than other tested seed size class. Bold seeded (B) and medium (m) seed size class has taken similar time to come into flowering, both are proven superior over small (S) seed size class (62.3 days). Significant interaction effect was also recorded in some of the treatment combinations. Extra bold seed size class in combination shallow depth of sowing (EBDI) comes into the flowering in the earliest time (57.5 days). The EBDI treatment combination took significantly lesser time

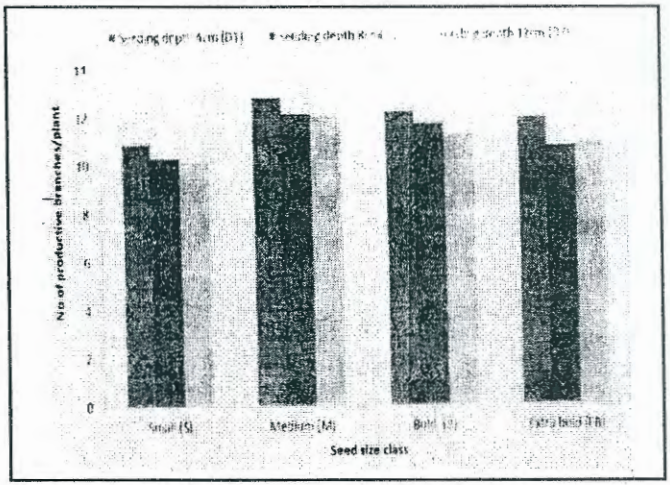

Fig. 3 : Effect of seed size class and depth of sowing on productive branches per plant.

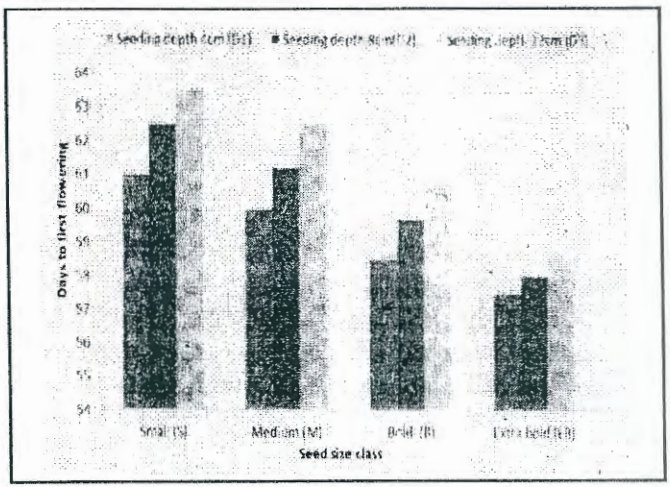

Fig. 4 : Effect of seed size class and depth of sowing on days taken to first flowering (Anthesis).

(57.3 days) for anthesis over small (S) (63.5 days), medium (M) (62.5 days) and bold (B) (60.7 days) seed size class of tested faba bean sown at maximum depth (D3). Results were in close conformity with Abdel Latif (2008), Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

Pod per plant (number)

Pod per plant is one of the major yield attribnting traits of faba bean. Pod per plant is influenced significantly with both the factor under study. Gradual increasing in depth of seeding bears lesser number of pods per plant. Significantly higher number of pod per plant was recorded (43.2 pod/plant) with shallow depth of seeding (D1) as compared to maximum depth of sowing (D3) under the present investigation. The significant difference was noticed

Table 5 :Effect of seed size class and depth of sowing on of pod/plant.

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	54.2	52.9	51	52.7
Medium (M)	45.2	43	42	43.4
Bold (B)	39.1	37.5	36.2	37.6
Extra bold (EB)	34.5	33.8	32.2	33.5
Mean	43.25	41.8	40.35	

CD (Seed Size) at 5% = 1.5*
CD (Seeding Depth) at 5% = 1.3
CD (Seed Size × Seeding Depth) at 5% = 2.7
CV (%) = 13.9

Table 6 :Effect of seed size class and depth of sowing on pod lengths (cm).

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	4.36	4.28	4.32	4.32
Medium (M)	4.20	4.17	4.17	4.18
Bold (B)	4.12	4.08	4.05	4.08
Extra bold (EB)	4.35	4.30	4.20	4.28
Mean	4.26	4.21	4.19	

CD (Seed Size) at 5% = 0.07*
CD (Seeding Depth) at 5% = 0.07
CD (Seed Size × Seeding Depth) at 5% = 0.12
CV (%) = 12.0

Table 7 :Effect of seed size class and depth of sowing on grain per pod (nos.).

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	4.15	4.10	4.00	4.07
Medium (M)	3.70	3.65	3.45	3.60
Bold (B)	3.15	2.95	3.05	3.05
Extra bold (EB)	2.90	2.70	2.70	2.73
Mean	3.44	3.35	3.30	

CD (Seed Size) at 5% = 0.17*
CD (Seeding Depth) at 5% = 0.15
CD (Seed Size × Seeding Depth) at 5% = NS
CV (%) = 11.2

Table 8 :Effect of seed size class and depth of sowing on seed yield (g/plant).

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	39.3	38.7	38.7	38.9
Medium (M)	40.6	38.8	37.5	39.0
Bold (B)	38.6	36.5	34.9	36.7
Extra bold (EB)	35.1	34.3	34.3	34.6
Mean	38.4	37.1	36.4	

CD (Seed Size) at 5% = 1.38*
CD (Seeding Depth) at 5% = 1.20
CD (Seed Size × Seeding Depth) at 5% = 2.40
CV (%) = 14.7

among in case of shallow depth (D1) of sowing over medium depth of sowing (D2) and medium depth of sowing (D2) over maximum depth of sowing (D3). Seed size class had also exerted significant impact on number of pod per plant. Number of pod per plant is by and large governed by its genetic makeup and up to considerable extent by management practices. Each seed size class is unique and distant from each other. Maximum number of pod per plant (52.7) was recorded with small (S) seed size class; whereas minimum (33.5) was obtained with extra bold (EB) seed size class (Fig. 5). The interaction effect of both the factor (sowing depth and seed size class) showed that maximum number of pod per plant (54.2) was recorded with small seed size class planted at shallow depth of planting (SDI) similarly, lower number of pod per plant was recorded to the extent of 32.2 when extra bold seed size class was sown at maximum tested depth (EBD3). The same conclusion was reached by Stutzel & Aufhammer (1992) and Abdel Latif (2008).

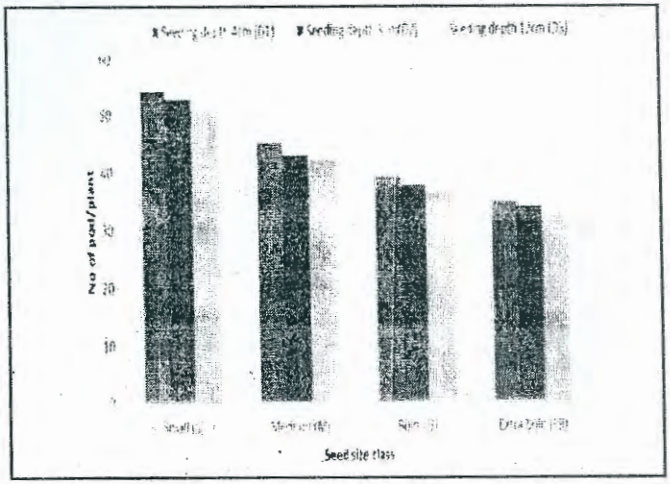

Fig. 5 : Effect of seed size class and depth of sowing on no. of pod/ plant.

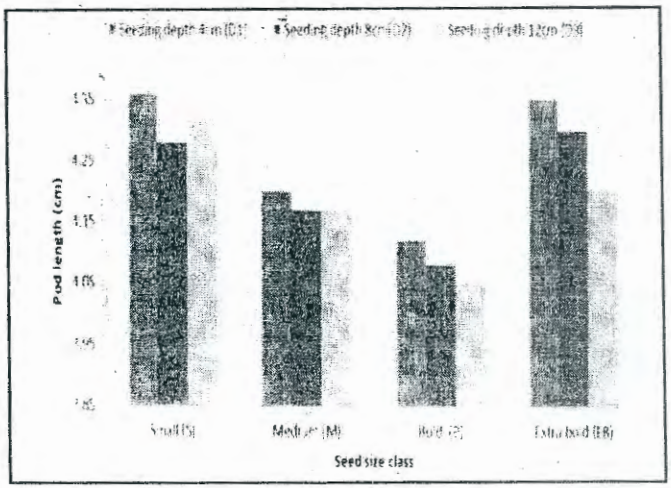

Fig. 6 : Effect of seed size class and depth of sowing on pod lengths (cm).

Pod length (cm)

Pod length is one of the crucial yield deciding factors, contributing positively in seed yield. By and large this trait (length of pod) is functional output of polygene and its interaction (lesser degree) with environmental condition prevails during growing season. Seeding depth had no significant bearing on pod length. Seed size class had recorded significant effect on pod length. Bold seeded (B) seed size class recorded minimum pod length (4.08cm); maximum was noted to the extent of 4.32cm in case of small (S) seed size class. None of interactions was found up to the mark. The same conclusion was reached by Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

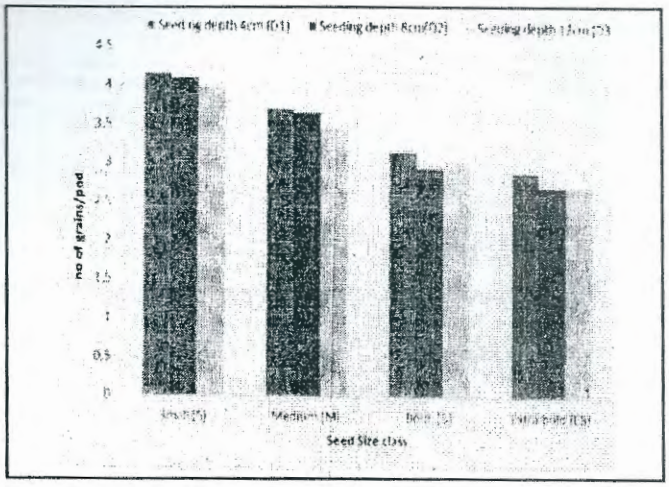

Fig. 7 : Effect of seed size class and depth of sowing on grain per pod (nos.).

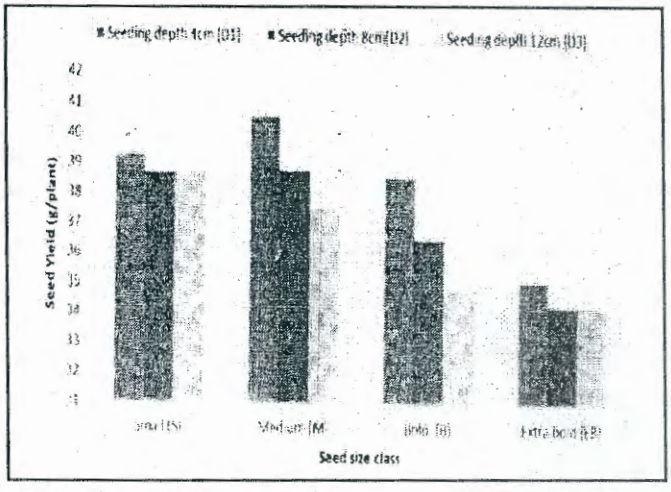

Fig. 8 : Effect of seed size class and depth of sowing on seed yield (g/plant).

Grain per pod (number)

Number of grain per pod is yield determining trait. In this present study data revealed that with the increase in depth of sowing the number of grain per pod was recorded in decreasing trend, though the decrease was non-significant among the depth of seeding. Seed size class had considerable influence on grain per pod. Small (S) seed size class produced maximum grain per pod (4.07) and decreased significantly with increase in boldness in seed size class up to the tested boldness i.e. extra bold (EB) to the extent of 2.73 grains per pod. No significant interaction was noticed among the tested levels of both the factor. Similar results were reported by Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

Table 9 :Effect of seed size class and depth of sowing on yield (kg/ha).

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	3585.5	3528.9	3493.5	3536.0
Medium (M)	3689.8	3715.5	3667.3	3690.9
Bold (B)	3574.1	3480.4	3354.9	3469.8
Extra bold (EB)	3297.1	3276.5	3165.4	3246.3
Mean	3536.6	3500.3	3420.3	

CD (Seed Size) at 5% = 91.8*
CD (Seeding Depth) at 5% = 68.5
CD (Seed Size X Seeding Depth) at 5% = 159.0
CV (%) = 13.2

Table 10 :Effect of seed size class and depth of sowing on 100 seed weight (g).

Treatments	Seeding depth			
Seed size class	D1	D2	D3	Mean
Small (S)	18.9	18.2	18.7	18.6
Medium (M)	26.7	26.4	26.1	26.4
Bold (B)	32.8	32.4	32.6	32.6
Extra bold (EB)	39.9	39.1	38.6	39.2
Mean	29.6	29.0	29.0	

CD (Seed Size) at 5% = 0.35*
CD (Seeding Depth) at 5% = 0.30
CD (Seed Size X Seeding Depth) at 5% = 0.61
CV (%) = 12.4

Seed yield per plant (g)

Faba bean seed yield per plant is determined by numerous factors but basically governed by its varietal characters and its management practices under prevailing agro climatic condition. Faba bean poses high degree of plasticity which enables this crop to complete its life cycle (seed to seed) under adverse circumstance and perform best with conducive and congenial situation with efficient agronomic management conditions. In this investigation result indicated that with every increase in sowing depth the seed yield per plant was decreased, though the significant effects was noticed at shallow depth of sowing (D1) in comparison to other two tested depth of sowing (D2 & D3). No significant difference was noticed between D2 & D3 depth of sowing. Maximum seed yield (38.4g per plant) was recorded with shallow depth of sowing (D1). Among the seed size classes, medium (M) seed size produced maximum seed yield (39.4g per plant), whereas minimum (34.7g per plant) was noticed with extra bold (EB) seed size class. Medium (M) seed size class produced equal to small seed size class (S) and significantly higher seed yield over other two tested seed size class i.e. bold (B) and extra bold (EB). Significant interaction was recorded with medium bold (MB) seed size class at shallow depth of sowing (26.8). Minimum seed yield (34.9 g per plant) was recorded with extra bold (EB) seed size class when sown at maximum depth (D3). Maximum seed yield (40.6 g per plant) in interaction was obtained where medium seed size class (M) was sown at shallow depth (D1). Similar results were reported by Alghamdi (2002) and Abdel Latif (2008).

Seed yield per ha (kg)

In protein yielding crops seeds are store house hence, most economical part, faba bean is good source of protein used for variety of purposes. Seed yield is resultant of series of successful event and governed by multiple factors including its heredity characters (being a polygenic trait) and agro-climatic conditions and agronomic management practices. Both the factors had influenced the seed yield of faba bean. In case of depth of seeding, with the

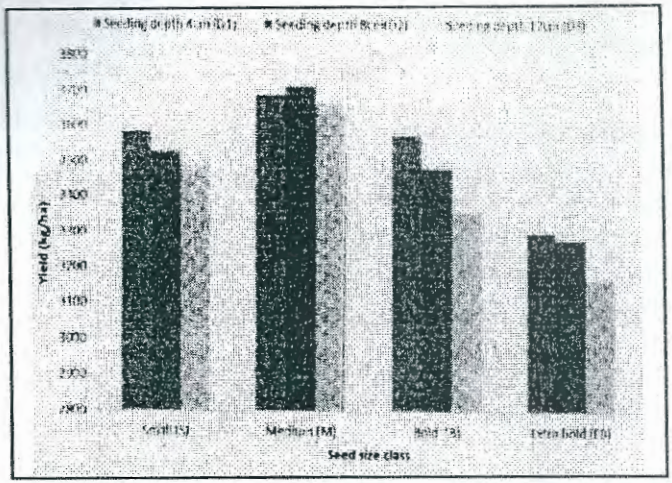

Fig. 9 : Effect of seed size class and depth of sowing on seed yield (kg/ha).

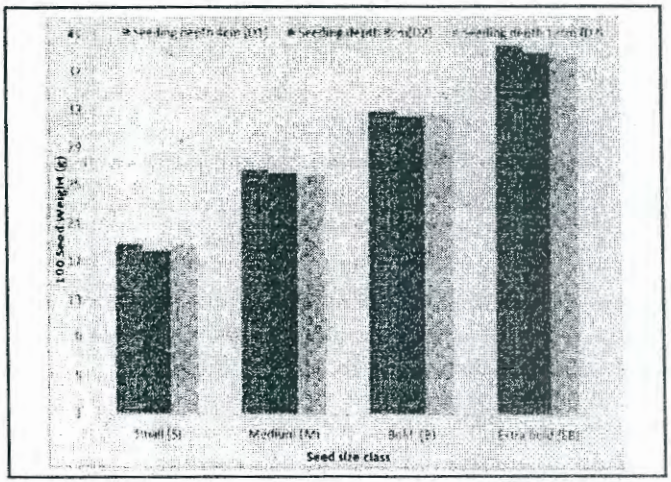

Fig. 10 : Effect of seed size class and depth of sowing on 100 seed weight (g).

increase of seeding depth the seed yield decreased up to the tested depth in this investigation with a maximum seed production of 3536.6 kg per ha in shallow depth of planting (D1) and minimum was obtained (3420.3 kg) with maximum depth of sowing (D3). Medium depth of seeding (D2) produced seed similar to D1 depth of sowing and significantly higher than D3 sowing depth. Seed size class was made on the basis of their seed weight and boldness, had also affected seed yield. Maximum and minimum seed yield (3690.9 kg) and (3246.3 kg) was recorded with medium (M) and extra bold (EB) seed size class, respectively. It is interestingly noted that each seed class significantly varied in seed production per hectare. Significantly higher and maximum seed yield (3715.5 kg) was recorded with medium seed size class sown at medium depth (MD2), the minimum (3354.9 kg) was recorded with extra bold seed size class sown at deeper depth (EBD3). The significant interaction effect was

noticed in case of bold seed size class sown at shallow depth (D1) over deep sowing (D3) (Fig. 9). Similar findings were also reported by Abdel Latif (2008) and Singh *et al.* (2010).

100-Seed weight (g)

Seed weight is strictly a predominant genetic character hence generally not influenced significantly with environmental conditions and management practices including other inputs. Depth of sowing had not at all affected the 100 seed weight (g), whereas seed size class behaves according to their classification and grouping. No segregation took place. None of the interaction found up to the mark of significant level (Fig. 10). Similar results were reported by Singh *et al.* (2010), Stutzel Aufhammer (1992) and Turk and Tawaha (2002).

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