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Effect of Seed Size and Seeding Depth on Fava Bean (*Vicia fava* L.) Productivity

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Abstract

The four seed size classes and the three seeding depth were organized in factorial experiment in complete randomized block design with four replications to ascertain the effect of seed size class and depth of sowing on growth and yield. Quickest and slowest time taken to complete 50% germination by extra bold seeded group sown at shallow depth (6.5 days) and small seeded class (S) sown at maximum depth (D_3) to the extent of 11.5 days. Shallow depth of seeding of medium seed size class (D_1M) produced tallest plant (88.7 cm) whereas minimum (79.4 cm) was noticed in small seed class and deeper depth of seeding. Medium (M) seed size class produced maximum no of productive branches (12.3) which is proved superior over other tested seed size class. Extra bold seed size class in combination shallow depth of sowing (EBD_1) comes in to the flowering in the quickest time (57.5 days). Maximum number of pod per plant (54.2) was noticed with small seed size class planted at shallow depth of planting (SD_1) and corresponding minimum to the extent of 32.2 with extra bold seed size class was sown at maximum tested depth (EBD_3). Maximum pod length was recorded (4.32 cm) with (S) seed size class which also produced maximum grain per pod (4.07) and decrease significantly with increase in boldness in seed size class. Maximum seed yield (40.6 g per plant) was obtained when medium seed size class (M) was sown at shallow depth (D_1) and minimum (34.9 g per plant) with extra bold (EB) seed size class when sown at maximum depth (D_3). Fava bean seed yield maximum (3,715.5 kg) was recorded in case of medium seed size class sown at medium depth (MD_2) whereas corresponding minimum (3,354.9 kg) was recorded with extra bold seed size class sown at deeper depth (EBD_3). Unit seed weight is basically governed by genetic makeup and hence seed size class behaves according to their classification and grouping.

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

The fava bean (*Vicia fava* L.) it is popularly know Kala Matar and Bakala. Central Asia and the Mediterranean region have been proposed as possible centers. According to United Nation, Food and Agricultural Organization (FAO), China is currently the world leading producer with 60% of the total. Other important producers are northern Europe, the Mediterranean, Ethiopia, Central and East Asia and Latin America (1). Fava 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. It is rich source of lysine rich protein contains (20—40%) depending upon cultivars and agro-climatic conditions under which fava 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. It also causes gas and abdominal pain due complex carbohydrates known as oligosaccharides. The anti nutrients and toxins are associated with the seed coat, sprouting the seeds generally reduces the level of toxins. Potential use of fava 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 and in Bihar as well. 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. The preseut study was an attempt to find out the effects of different seed size classes and Fava bean (*Vicia fava* L.) is cool winter *rabi* season crops in India, can tolerate wide range of climatic adversity, soil type and pH, but prefers well drained fertile loamy soil with

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

one two irrigation. In Bihar particularly in northern districts which is frequently affected by flood (Samastipur, Muzaffarpur, Sitamarhi, Darbhanga to name a 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 with no due care. To optimized the production potential of this crop a research trail was conducted on two agronomic aspects, seed size and seeding depth to ascertain the role of these two factors determining the growth, yield component and finally yield of fava bean under Bihar condition.

Methods

The field experiment was conducted at Crop Research Program, 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 consisted of four seed sizes and three seeding depths. The seed were sorted out into four sizes from the core collection made from the farmer's field/threshing floors from northern district of Bihar while conducting participatory research appraisal (PRA). These are mainly local cultivars being under cultivation since long. The four seed size classes are based on their boldness measured by their 100 seed weight and classes are made as small (15.6 g), medium (26.5 g), bold (334 g) and extra bold (44.5 g). These classes are denominated as S, M, B and EB respectively. Similarly seeding depth was kept 4, 8 and 12 cm and designated as D_1, D_2 and D_3 respectively. The four seed size classes and the three seeding depth were combined together consisting 12 treatments which were organized in factorial experiment in complete randomized block design 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 pant spacing respectively, putting three seeds iu each hole. To ensure the plant seeds at desired depth of 4, 8 or 12 cm holes are made. After fortnight of sowing operation plants were thin out keeping two healthy plants per hole to maintain optimum plant population. The size of plots was 5 m × 4 m. Standard package of practices were adopted as in legume crops. Crop was fertilized with NPK at 20:50:40 kg/ha respectively. Two irrigation was given at grand growth phase and pre flowering stages during both the seasons. One hand weeding was carried out at initial stages of crop growth. No major incidence of pests and disease was noticed during the course of experimentation. Germination of seeds was satisfactory during the both the season hence crop stand was normal. Weather condition of Pusa, Bihar, was within the range during the experimental period of both seasons. Data were recorded on growth, yield attributes and yield and as per requirements 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 was recorded and computed at harvest, observations were recorded for five sampled plant and averaged. Pooled

Table 3. Effect of seed size class and depth of sowing on nos of productive branch/plant. CD (Seed size) at 5% = 0.6, CD (Seeding depth) at 5% = 0.5, CD (Seed size × Seeding depth) at 5% = 1.0, CV (%) = 15.1.

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

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).

Results and Discussion

Days Taken to 50% Germination

Fava 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 toward the activation of life cycle, which takes place under favorable 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 fava bean having a robust tap root with profusely branched secondary roots. Table 1 confirms that with each increase in depth of seeding delayed the germination by time taking more time to emerge. Medium depth of sowing (D_2) takes (8.5 days) significantly more (7.8 days) and less (9.5 days) time than shallow (D_1) and deep depth (D_3) of sowing respectively. Boldness of seed had direct and positive bearing on early emergence. Extra bold seed size class taken minimum duration to germinate (7.2 days) whereas maximum was taken by small seeded group (10.5 days). Medium size seed class (M) took (8.7 days) significantly minimum and maximum time to 50% 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 take to 50% germination. Small seeded seed size class takes significantly minimum time (9.5 days) to germinate when sown at shallow depth (SD_1) over deep sowing (11.5 days). The same trend was noticed for all the seed size class (Table 1). Quickest and slowest to complete 50% germination by extra bold seeded group sown at shallow depth (6.5 days) and small seeded class (S) sown at maximum depth (D_3) was 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 (1—3).

Plant Height (cm)

Height of fava bean plant is largely governed by its genetic makeup and their growing environment. Fava bean employs a high degree of plasticity (4). Shallow depth of seeding at (D_1) recorded significantly taller plant compared to deep seeding (D_3). Seed size class and sowing dates both had significant effects on plant height. Medium seed size class produced tallest plant (86.5 cm), significantly superior over small (S) and extra bold (EB), whereas smallest plant was recorded in small seed size class (1, 3, 5). The significant interaction among the treatment combinations (seeding depth and seed size class) was also recorded. Maximum plant height (88.7 cm) was noticed when medium size seed class was sown at shallow depth (D_1), whereas minimum (79.4 cm) was noticed in small seed class and deeper depth of seeding. Treatment combination (D_1M) produced tallest plant (88.7 cm) than small seed class sown at any depth of sowing and extra bold seed class (EB) sown at D_2 and D_3 depth of planting (Table 2), (3—5).

Productive Branch per Plant (Number)

Number of the pod bearing branched is known as productive branches, is one of the yield attribut-

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

ing traits. Depth of seeding had significantly influenced the productive branch per plant. Shallow depth of seeding (D_1) produced significantly higher productive branches (12) over other two studied depths of sowing in the present investigation (Table 3). There is no significant difference among two other test depths of sowing (D_2 and D_3) in respect to productive branch per plant, produced 11.2 and 11 respectively. Seed size class had also influence the productive branch. Medium (M) size class produced maximum no of productive branches (12.3) which is proved superior over other tested seed size class (2—4).

Days Taken to First Flowering (Anthesis)

Being a leguminous crop, indeterminate growth habit is a major genetic feature which provide unique opportunity to plant to after certain period of time of vegetative growth plants start simultaneously both the activity i.e. vegetative and reporductive phase. Early onset of reproductive phase which start with flowering, provide extra time for economic produce (Seed formation). In the light of these studies on days taken to first flowering (anthesis) has been undertaken for fava bean. The data revealed that with the increasing depth of seeding the days to on set of first flowering prolonged (Table 4). Shallow depth of seeding (D_1) takes significantly minimum time (59.3 days) over other two tested depth of seeding. Seed size class had also significant influence on flowering of fava bean. Extra bold seed size class (EB) produced first flower in earliest time (58 days) than other testes seed size class. Bold Seeded (B) and medium (M) seed size class taken similar time to come in to 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 (EBD_1) comes in to the flowering in the earliest time (57.5 days). The EBD_1 treatment combination takes significantly lesser time (57.3 days) to anthesis over small (S) (63.5 days) and medium (M) (62.5 days) and bold (B) (60.7 days) seed size class of tested fava bean sown at maximum depth (D_3), (2—4).

Pod Per Plant (Number)

Pod per plant is one of the major yield attributing traits of fava 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 (Table 5). Significantly higher number of pod per plant were recorded (43.2 pod/plant) with shallow depth of seeding (D_1) as compared to maximum depth of sowing (D_3). The significant difference was noticed among incase of shallow depth (D_1) of sowing over medium depth of sowing (D_2) and medium depth of sowing (D_2) over maximum depth of sowing (D_3). 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 (fava bean) genetic makeup and up to considerable extent by management practices. Each seed size class is unique and distant form each other. Maximum number of pod per plant (52.7) was recorded with small (S) seed size class ; where as minimum (33.5) was obtained with extra bold (EB) seed size class (2, 3, 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 (SD_1). Simi-

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

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

Table 8. Effect of seed size class and depth of sowing on see yield (g/plant). CD (Seed size) at 5% = 1.38, CD (Seedin depth) at 5% = 1.20, CD (Seed size × Seeding depth) at 5% 2.40, CV (%) = 14.7.

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

larly 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 (EBD_3).

Pod Length (cm)

Among others length of fava bean pod 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 (Table 6). 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 (4.08 cm) ; maximum was noted to the extent of 4.32 cm in case of small (S) seed size class. None of interactions was found up to the mark (significant level), (3, 4).

Grain Per Pod (Number)

Number of grain per pod is yield determining trait. The 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 (Table 7). Seed size class has considerable influence on grain per pod. Small (S) seed size class produced maximum grain per pod (4.07) and decrease 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 (2, 4, 5).

Seed Yield Per Plant (g)

Fava bean seed yield per plant is determine b numerous factor but basically governed by it varietal characters and its management practice under prevailing agro climatic condition. Fava bea possess high degree of plasticity which enables thi crop to complete his life cycle (seed to seed) unde adverse circumstance and perform best with condu cive and congenial situation with efficient agronomi management conditions (Table 8). The presents re sult indicate that with every increase in sowing dept the seed yield per plant was decreased, though th significant effects was noticed shallow depth of sow ing (D_1) compared to other tested depth of sowin (D_2 and D_3). No significant difference was notice be tween D_2 and D_3 depth of sowing. Maximum see yield (38.4 g per plant) was recorded with shallow depth of sowing (D_1). Among the seed size classes medium (M) seed size produced maximum seed yiel (39.4 g per plant), where as minimum (34.7 g per plan was noticed with extra bold (EB) seed size class. Me dium (M) seed size class produced equal to small see size class (S) and significantly higher seed yield ov other two tested seed size class i.e. bold (B) and extr bold (EB). Significant interaction was recorded wit medium bold (MB) seed size class at shallow depth o sowing. Minimum seed yield (34.9 g per plant) wa recorded with extra bold (EB) seed size class whe sown at maximum depth (D_3). Maximum seed yiel (40.6 g per plant) in interaction was obtained when medium seed size class (M) was sown at shallow dept (D_1), (2, 5).

Seed Yield Per Ha (kg)

In protein yielding crops seeds are store house hence most economical part, fava bean is good sourc

Table 9. Effect of seed size class and depth of sowing on yield (kg/ha). CD (Seed size) at 5% = 91.8, CD (Seeding depth) at 5% = 68.5, CD (Seed size × Seeding depth) at 5% = 159.0, CV (%) = 13.2.

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

Table 10. Effect of seed size class and depth of sowing on 100 seed weight (g). CD (Seed size) at 5% = 0.35, CD (Seeding depth) at 5% = 0.30, CD (Seed size × Seeding depth) at 5% = 0.61, CV (%) =12.4.

Treatments	Seeding depth			
Seed size class	D_1	D_2	D_3	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	

of protein used for variety of purposes. Seed yield is resultant of series of successful events and governed by multiple factors including its heredity characters (being a polygenic trait) and agro-climatic conditions and agronomic manageunent practices. Both the factors influenced the seed yield of fava bean. In depth of seeding, with the increase of seeding depth the seed yield decrease up to the tested depth in this investigation, with a maximum seed production of 3,536.6 kg per ha in shallow depth of planting (D_1) and minimum was obtained (3,420.3 kg) with maximum depth of sowing (D_3). Medium depth of seeding (D_2) produced seed similar to D_1 depth of sowing and significantly higher than D_3 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 (3, 690.9 kg) and (3246.3 kg) was recorded with medium (M) and extra bold (EB) seed size class respectively. It interestingly noted that each seed class siguificantly varied in seed production per hectare. Significantly higher and maximum seed yield (3,715.5 kg) was recorded with medium seed size class sown at medium depth (MD_2) the minimum (3,354.9 kg) was recorded with extra bold seed size class sown at deeper depth (EBD_3). The significant interaction effect was noticed in case of bold seed size class sown at shallow depth (D_1) over deep sowing (D_3) (Table 9) (4, 5).

100-Seed Weight (g)

Seed weight is strictly a predominant genetic character, hence generally not influenced significantly with environmental conditions and managemental practices including other inputs. Depth of sowing had no affect on the 100 seed weight (g) (Table 10) whereas seed size class behaves according to their classification and grouping (3—5).

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