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Seasonal Influence on Yield and Yield Contributing Characters of Lablab Bean [*Lablab purpureus* (L.) Sweet]

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Abstract

A study was conducted to evaluate the seasonal influence on yield and yield contributing characters of four lablab bean genotypes: IPSA Seam-1, IPSA Seam-2, BU Seam-3 and JER during September 2000 to December 2001 covering one main season (winter) and two off-seasons (early summer and late summer). Compared to off-seasons, all the genotypes performed better for all the parameters during winter. Every delay in planting was associated with significant reduction in yields and all yield contributing characters. Pod setting was reduced during late summer in all the genotypes. IPSA Seam-2 produced the highest number of seeds per pod in all the seasons. The number of seeds per pod was greatly reduced in all genotypes during late summer. Most of the agronomic traits: number of inflorescence per plant, number of flower buds per inflorescence, number of pod set per inflorescence, number of pod per plant, single pod weight etc. were affected severely during off-seasons irrespective of genotypes. Lower number of pods and yield per plant in summer was accounted for by poorer viability, germination rate and tube growth of pollens resulting in 63 – 96% reduction in yield.

***Keywords**:* Lablab bean, *Lablab purpureus,* yield, yield contributing characters

1. Introduction

Lablab bean (*Lablab purpureus* (L.) Sweet) is normally a self-pollinated and photosensitive crop. Due to its photo- and/or thermo-sensitive behaviour, availability of lablab bean in our market is restricted during winter months, when a lot of other vegetables are available. To make it available in the market beyond winter season, photo- and/or thermo insensitive varieties of lablab bean have been recently developed through genetic manipulation which are genetically day neutral having year round/off-season flowering/fruiting characteristics (Chowdhury *et al.*, 1989). Year round pod bearing potentiality of those day neutral varieties could not be exploited efficiently due to poor retention of flowers/fruits during off-season. However, their yields are generally poor due to reasons, which are still unidentified. The common bean (*Phaseolus vulgaris* L.) is particularly sensitive to vagaries of weather. Pod and seed setting, flower abscission, flower abortion in common bean are associated with environmental factors ((Konsens *et al.*, 1991; Davis, 1945; Smith and Pryor, 1962; Stobbe *et al.*, 1966; Ormrod *et al.*, 1967; Kambal, 1969;

Rowland, 1960). However, information on the influence of environmental factors on the yield and yield contributing characters of lablab bean in Bangladesh is very scanty. The present study was therefore, carried out to identify the factors limiting lablab bean yield in off-season as compared to winter – the normal season.

2. Materials and Methods

The study was conducted separately in three seasons at the Horticultural Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur with four lablab bean genotypes – IPSA Seam-1, IPSA Seam-2, BU Seam-3 and JER (one parent of other three genotypes) during September 2000 to December 2001 covering three seasons: main season – winter (October – January) and two off-seasons – early summer (February – May) and late summer (June – September). The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 5 X 4m accommodating two rows per plot and 3 pits per row. Pit to pit and row to row spacing were 1.5m and 2m respectively. Two seeds of each genotype were sown per poly bag (12 X 18cm) containing a mixture of equal proportion of well-decomposed cowdung and loamy soil on October 1, 2000 for winter, February 15, 2001 for Early summer and June 9, 2001 for Late summer respectively. Fifteen days old seedlings were transplanted to the experimental plots. The land was fertilized with cowdung, oil cake, urea, TSP and MP @ 33000, 660, 80, 166 and 66 kg/hectare respectively. The full amount of cowdung, oil cake and TSP, one-third of MP and urea were applied basally in the pits one week before transplanting and mixed with the pit soil. The remaining amount of MP and urea were applied in three equal installments as top dressing at 15, 30 and 45 days after transplanting. The plants were initially irrigated by watering cane and later on surface irrigation was given whenever required. The crop was protected from the attack of insect pest mainly aphids, jute hairy caterpillar and pod borers by regular spraying of Nogos @ 2 ml/lit. water. The soil of the experimental field was clay loam in texture and acidic in nature with P^H of 5.8. The daily average temperature, daily average relative humidity and monthly rainfall of the three seasons were respectively (a) winter – 21.94^0C, 70.80% and 13.17 mm, (b) early summer – 27.96^0C, 72.02% and 205.98 mm and (c) late summer 29.96^0C, 81.06% and 307.22 mm. Data were recorded on the following parameters:

2.1. Days to first anthesis

The number of days from seed sowing to first flower bud opening was recorded in each plant and the average was calculated.

2.2. Number of floral buds per inflorescence

Number of floral buds per inflorescence was recorded from 30 (10 + 10 + 10) randomly selected inflorescence per plant. It was done at 75, 85 and 95 days after sowing (DAS) and the average were calculated.

2.3. Percent open flower

It was done by using the following formula:

$$\text{Percent open flower} = \frac{\text{No. of open flower per inflorescence}}{\text{No. of total floral buds per inflorescence}} \times 100$$

2.4. Number of pod set per inflorescence

Number of pod set per inflorescence was recorded from 10 randomly selected inflorescence per plant at 75, 85 and 95 DAS and the average was calculated. Then pod set percentage was estimated as :

$$\text{Pod set percentage} = \frac{\text{No. of pod set per inflorescence}}{\text{No. of open flower per inflorescence}} \times 100$$

2.5. Number of inflorescence per plant

Number of inflorescence per plant was counted by tagging the inflorescence of randomly selected two plants per plot at weekly interval during the flowering period and the cumulative number were recorded as total number of inflorescence per plant.

2.6. Number of pods per inflorescence

Number of pod harvested per inflorescence was recorded from 30 (10 + 10 + 10) randomly selected inflorescence per plant at three stages as mentioned above. Single pod weight was estimated by weighing 30 (10 + 10 + 10) randomly selected pods at three stages as mentioned above.

2.7. Pod size

2.7.1. Length and Width

Ten randomly selected green pods per treatment were measured after harvest at three stages as mentioned before.

2.7.2. Number of pods per plant

The number of pods per plant was counted at every weekly harvest from five selected plants per plot and the cumulative number of pods was recorded as total number of pods per plant. The seeds, which had well developed cotyledons and smooth and uniform seed surface were considered to estimate the number of seeds per of randomly selected twenty pods per plant.

2.7.3. Weight of 100 ripe seeds

The weight of 100 randomly selected ripe seeds was measured after harvest at three stages as mentioned before.

2.7.4. Green pod yield

The weight of green pods per plant was measured for every harvest at weekly interval and the cumulative weight of pods was recorded as green pod yield per plant and converted into pod yield per hectare.

Data on different parameters were statistically analyzed with the help of computer "MSTAT-C" program following the factorial RCB design as suggested by Gomez and Gomez (1984). The differences among treatment means were compared by Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Days to first anthesis

Table 1 shows that the genotype JER needed 6 days longer time to reach anthesis stage than IPSA Seam-1 and BU Seam-3. The genotypes took shorter time to flower in winter than in summer. Noticeable increase in days to first anthesis in all genotypes was observed in summer than in winter, indicating delayed flower formation under high temperature condition. High temperature probably interrupted the process of flower formation. Aung (1976); Charles and Harris (1972) and Kuo *et al*. (1979) also reported that flower formation is affected by high temperature.

3.2. Number of flower buds per inflorescence

There was a wide variation among the genotypes regarding number of flower buds per inflorescence. The genotype JER was superior to IPSA Seam-1 and BU Seam-3 but it was closely followed by IPSA Seam-2. This difference among the genotypes might be attributed to their genetic make up. The number of flower buds was much higher in winter than those in early or late summer, which ranged from 26.86 in late summer to 33.85 in winter. As regards the interaction between genotypes and seasons, number of flower buds per inflorescence widely varied among the treatments. JER in winter produced the highest number of flower buds per inflorescence but it produced significantly lower number of flowers buds in early or late summer than in winter. The seasons however, did not have any influence on flower bud production of IPSA Seam-2 and BU Seam-3. IPSA Seam-1 produced the highest number of flower buds in winter among the three seasons. Production of flower buds in early or late summer was identical for all the genotypes.

3.3. Percentage of flower buds opened

There was a wide variation among the genotypes in respect of percentage of flower buds opened (Table 1). The genotype IPSA Seam-2 and BU Seam-3 were identical but they had significantly higher percentage of flower buds that opened than the two other identical genotypes – IPSA Seam-1 and JER. Neither the season nor the interaction between genotypes and seasons had any significant influence on this parameter.

Table 1. Influence of genotypes and seasons on flowering and fruiting of lablab bean

Observation		Days from sowing to 1st anthesis	No. flower buds/ inflorescence	% of flower buds that opened	No. of pod set/ inflorescence	% of flower setting pods
Genotypes						
IPSA Seam-1	(C_1)	52.37 c	27.53 bc	54.30 b	4.51 c	29.63 b
IPSA Seam-2	(C_2)	56.66 ab	31.63 ab	70.94 a	6.58 b	30.94 b
BU Seam-3	(C_3)	53.95 bc	25.84 c	75.20 a	3.13 d	15.93 c
JER	(C_4)	58.09 a	32.51 a	60.13 b	10.71 a	55.16 a
Seasons						
Winter	(S_1)	50.02 b	33.85 a	67.01	8.89 a	39.94 a
Early summer	(S_2)	59.11 a	27.43 b	62.92	6.61 b	39.83 a
Late summer	(S_3)	56.67 a	26.86 b	65.50	3.23 c	18.98 b
Seasons X Genotypes						
S_1	C_1	48.17	31.64 bc	54.22	7.40 c	43.73 bc
	C_2	50.58	33.93 b	77.48	8.10 c	31.06 cd
	C_3	49.67	27.20 cde	78.93	4.27 de	20.06 def
	C_4	51.67	42.61 a	57.40	15.67 a	64.91 a
S_2	C_1	55.60	25.33 de	53.00	3.38 def	25.72 de
	C_2	61.40	30.80 bcd	64.67	8.16 c	45.32 b
	C_3	58.17	25.31 de	75.67	3.50 def	18.52 def
	C_4	61.26	28.27 bcde	58.33	11.40 b	69.74 a
S_3	C_1	53.33	25.62 de	55.67	2.76 ef	19.44 def
	C_2	58.00	30.17 bcde	70.67	3.47 def	16.42 ef
	C_3	54.00	25.00 e	71.00	1.62 f	9.20 f
	C_4	61.33	26.67 cde	64.67	5.07 d	30.85 cd
CV (%)		4.90	11.60	9.03	14.11	18.01

Values within a column with same letter do not differ significantly.

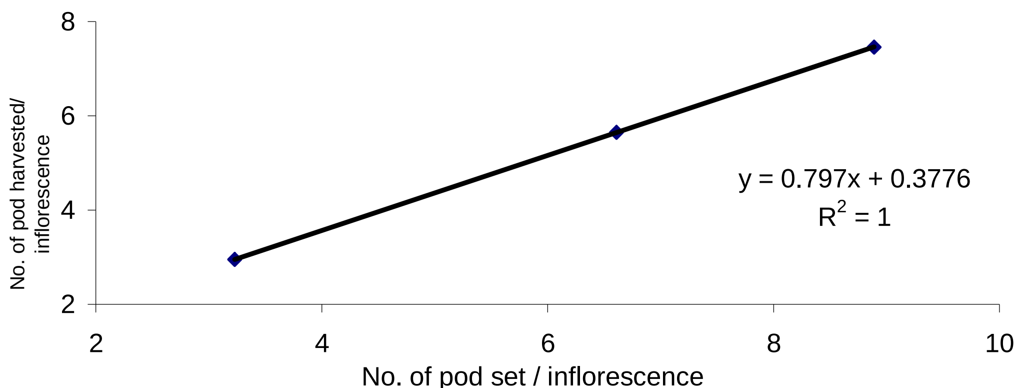
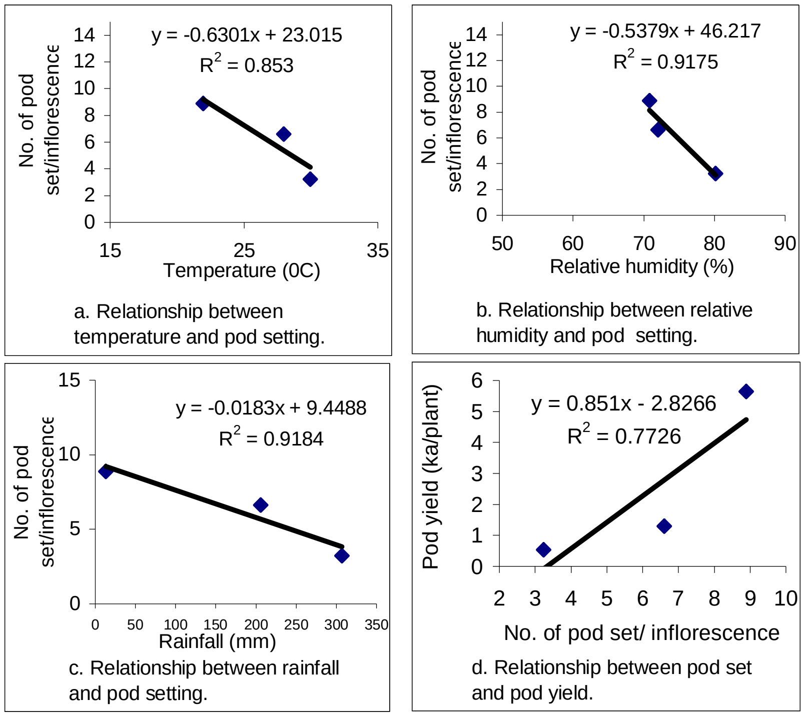


Fig. 1. Relationship between no. of pod set and no. of pod harvested per inflorescence.



a. Relationship between temperature and pod setting.

b. Relationship between relative humidity and pod setting.

c. Relationship between rainfall and pod setting.

d. Relationship between pod set and pod yield.

Fig. 2(a-d). Relationship between environmental factors and pod setting of lablab bean

3.4. Number of pods set per inflorescence

Both genotypes and seasons appreciably affected the number of pods set per inflorescence (Table 1). The genotypes, JER produced the highest number of pods per inflorescence (10.71), which was widely followed by IPSA Seam-2, IPSA Seam-1 and BU Seam-3. The number of pods set and number of pods harvested per inflorescence was strongly correlated (Figure 1). This indicates that many of the flower buds as well as the flowers dropped off before setting pod, but very little or no pod dropped off after setting. Nonetheless, with the increase in temperature, humidity and rainfall the number of pods set per inflorescence was decreasing significantly (Figure 2). Genotypes and seasons significantly interacted regarding number of pods set per inflorescence. The highest number of pods set per inflorescence was found with JER during winter. All the other genotypes were inferior to JER during all the planting seasons except IPSA Seam-2 which was identical to it in late summer. The genotypes had a general trend of decreasing pod set with advent of the season or with worsening environment. The number of pods set per inflorescence in IPSA Seam-2 and BU Seam-3 was identical for winter and early summer but it was reduced by over half in late summer.

3.5. Percentage of flowers setting pod

Table 1 shows that the highest percentage of flower (55.16%) setting pods was in the genotype JER and the lowest was in BU Seam-3 (15.93%). It is notable here that about half of the flowers set pods in JER, while about one third in IPSA Seam-1 and IPSA Seam –2 and one sixth in BU Seam-3. This indicates a much poorer yield potential of the latter three genotypes than the earlier one. Over 75% of the floral buds of field beans fail to produce pods in other experiments (Kambal, 1969), which is in agreement with these results. Seasons had marked influence on percentage of flowers setting pods. There was, however, no appreciable difference in pod set percentage between winter and early summer but it was reduced to more than half in late summer. This indicates that off-season beans grown in late summer passes through much less favourable environment. Dorland and Went (1947) stated that low night temperature ensured higher fruit set in chilli, which is in agreement with the present findings. High temperature reduces indole-3-acetic acid levels and particularly auxin transport capacity in the reproductive organs and the reduction of auxin transport capacity is the major mechanism by which high temperature induces reproductive organ abscission in pepper (Hubermam *et al.*, 1997) and in tomato after anthesis (Iwahori, 1964). It was also reported that the levels of endogenous auxin in young pods of lablab bean varieties drastically reduced in kharif as compared with rabi season. Deviation from a certain level of auxin content, growth and development of pod are hampered (Nasreen, 1999).

The interaction between genotypes and seasons was significant. The highest pod set percentage was found with JER when grown either in winter (64.91%) or early summer (69.74%). The genotype IPSA Seam-1 had significantly higher pod set in winter (43.73%) than early or late summer. The genotypes IPSA Seam-1and BU Seam-3 had their pod set percentage half in late summer over the early summer. The reduction in pod set percentage with the advent of seasons was closely associated with the worsening of environmental conditions like temperature, relative humidity and rainfall (Fig. 2). Fig. 2d indicates a positive relationship between pod set per inflorescence and pod yield. About 77% of the pod yield was accounted for by number of pods set per inflorescence. These variations in pod set among the genotypes in different seasons might be due to flower drop or other embryological problems caused by adverse environmental conditions that prevailed during off-seasons. Adverse environmental factors reduced pollen viability, number of pollinated stigma, pollen germination and pollen tube growth in lablab bean (Uddin, 2003). Pod and seed setting depend largely on the degree of pollen transfer, compatibility, fertility of the gametes, successful pollination and fertilization (Zuberi and Sarker, 1992). The rate of pod abortion was 70% for IPSA Seam-1, 69% for IPSA Seam-2, 84% for BU Seam-3 and 45% for JER in the present experiment. In some condition, usually of very high rainfall, almost all the flowers can abort. This is considered a major factor-limiting yield in the crop (Rowland *et al.*, 1983). Furthermore, flower abortion has been considered a post-fertilization phenomenon caused by embryo abortion (Rowland, 1960).

3.6. Yield and yield contributing characters

3.6.1. Number of inflorescence per plant

Although the number of inflorescence per plant was influenced by genotypes there was not much difference among IPSA Seam-2, BU Seam-3 and JER (Table 2). The highest number of inflorescence was produced by IPSA Seam-1 (87.33), which was superior to all the other three genotypes but identical to BU Seam-3. Winter was superior to the other two seasons in producing identical number of inflorescence per plant, when the interaction between genotypes and seasons is considered. It is revealed from Table 2 that the genotypes had similar number of inflorescence per plant in early or late summer. The genotype IPSA Seam-1 was superior to other genotypes when grown in winter. The genotype IPSA Seam-2 produced similar number of inflorescence when planted in winter or late summer.

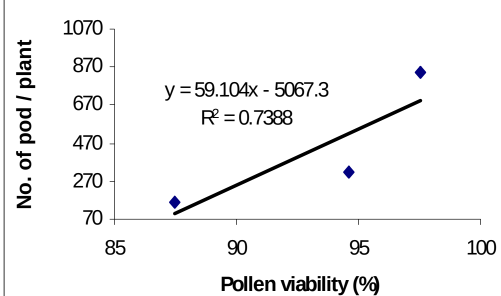
3.6.2. Number of pods harvested per inflorescence

Significant variation was found among the genotypes in respect of number of pods per inflorescence. Every genotype produced significantly different number of pods per inflorescence. The highest number of pods per inflorescence was produced by JER (9.44), which was followed by IPSA Seam-2 (5.22), IPSA Seam-1 (3.98) and BU Seam-3 (2.77).

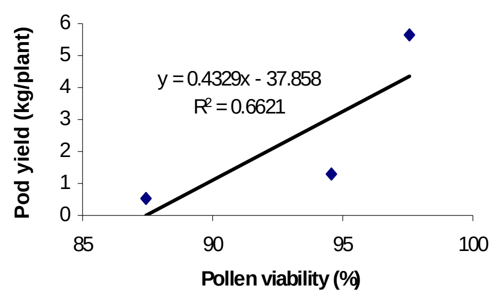
Table 2. Yield and yield contributing characters of lablab bean as influenced by season

Observation		No. of inflorescence / plant	No. of pod harvested/ inflorescence	Single pod wt. (g)	Pod size (cm)		No. of seed / pod	No. of pod / plant	Wt. of 100 ripe seed	Pod yield (t/ha)	% yield reduction with each delayed planting
					Length	Width					
Genotypes											
IPSA Seam 1(C_1)		87.33 a	3.98 c	6.10 ab	10.48 a	2.39 b	2.91 bc	458.11 b	31.66 a	11.48 a	
IPSA Seam 2(C_2)		56.22 b	5.22 b	5.78 b	7.41 c	2.12 c	3.89 a	373.11 bc	28.67 b	7.41 b	
BU Seam 3 (C_3)		74.78 ab	2.77 d	6.76 a	9.21 b	2.75 a	2.24 c	226.56 c	24.73 c	5.55 b	
JER	(C_4)	69.11 b	9.44 a	2.44 c	5.08 d	1.61 d	3.18 ab	706.00 a	20.87 d	5.41 b	
Seasons											
Winter	(S_1)	114.08 a	7.46 a	7.61 a	9.14 a	2.45 a	4.03 a	842.42 a	31.40 a	16.93 a	-
Early summer (S_2)		56.25 b	5.65 b	4.80 b	7.69 b	2.18 b	2.98 b	318.58 b	25.04 b	3.87 b	77.14
Late summer (S_3)		55.00 b	2.95 c	3.40 c	7.30 b	2.03 c	2.16 c	161.83 c	23.01 c	1.58 b	90.66
Season X Genotype											
S_1	C_1	169.33 a	6.67 c	9.18 ab	12.65 a	2.50 bc	4.20 a	1116.33 a	35.31 a	30.70 a	-
	C_2	91.33 bc	6.33 cd	8.35 b	8.41 d	2.47 c	4.23 a	584.33 b	31.15 bc	14.61 b	-
	C_3	96.33 b	3.83 ef	10.16 a	10.23 b	3.11 a	4.10 a	388.00 bc	32.11 b	11.83 b	-
	C_4	99.33 b	13.00 a	2.77 ef	5.27 f	1.70 e	3.57 a	1281.00 a	27.04 d	10.59 b	-
S_2	C_1	49.00 d	2.94 efg	5.67 c	9.99 bc	2.40 c	3.12 ab	155.33 c	30.03 bc	2.65 c	91.36
	C_2	55.00 d	6.00 cd	5.05 cd	6.86 e	1.94 d	3.83 a	330.00 bc	29.72 c	5.18 c	64.54
	C_3	65.67 bcd	3.00 efg	6.23 c	8.89 bcd	2.73 b	1.97 bc	197.00 c	20.06 e	3.70 c	68.72
	C_4	55.33 d	10.67 b	2.25 f	5.03 f	1.64 e	3.00 ab	592.00 b	20.34 e	3.94 c	62.79
S_3	C_1	43.67 d	2.33 fg	3.46 ef	8.80 bcd	2.26 c	1.40 c	102.67 c	29.63 c	1.09 c	96.45
	C_2	61.33 cd	3.33 ef	3.95 de	6.95 e	1.95 d	3.61 a	205.00 c	25.13 d	2.43 c	83.37
	C_3	62.33 cd	1.47 g	3.89 de	8.50 cd	2.42 c	0.67 c	94.67 c	22.02 e	1.11 c	90.62
	C_4	52.67 d	4.67 de	2.30 f	4.95 f	1.50 e	2.97 ab	245.00 c	15.24 f	1.70 c	83.95
CV (%)		**18.21**	**13.34**	**10.99**	**7.51**	**4.50**	**20.59**	**26.42**	**3.29**	**30.98**	

Values within a column with same letter do not differ significantly.



a. Relationship between pollen viability and No. of pod / plant.



b. Relationship between pollen viability and pod yield / plant.

Fig. 3. Relationship among pollen viability and pod yield of lablab bean.

Every delay in planting reduced the number of pods per inflorescence. The trend of change in number of pods harvested per inflorescence due to genotype or season was the same as with the change in the number of pods set per inflorescence. There was wide variation among the treatments in respect of number of pods per inflorescence due to interaction between genotypes and seasons. The highest number of pods per inflorescence (13.00) was harvested from JER in winter. The same genotype, however, had greatly reduced number of pods with every delay in planting with the late summer planting producing the lowest number of pods per inflorescence (4.67). There was slight difference in number of pods per inflorescence in IPSA Seam-1 between early and late summer sowing but the winter sowing was superior. In case of IPSA Seam-2 there was no statistical difference between winter and early summer sowing but the late summer sowing was inferior to the first two sowings. As regards the number of pods per inflorescence, BU Seam-3 in winter was superior to that in late summer but identical to early summer. The lowest number of pods per inflorescence (1.47) was produced by BU Seam-3 in late summer. The number of pods harvested per inflorescence had a significant positive correlation (r =0.99) with number of pods set per inflorescence indicating that the increased number of pods harvested per inflorescence was accounted for by the increased number of pods set per inflorescence (Figure 1). The increased number of pods set per inflorescence was, in turn, associated with the increased number of flower buds per inflorescence. The number of flowers per inflorescence, however, did not influence the number of pods per inflorescence.

3.6.3. Single pod weight and size

As regards single pod weight, BU Seam-3 (6.76 g) produced the heaviest pods which were closely followed by IPSA Seam-1. IPSA Seam-1 and –2 were identical in single pod weight, while JER produced the lightest pods. Single pod weight decreased with advent of seasons significantly. As far as the interaction between genotype and season is concerned there was a wide variation among the treatments. The highest weight of single pod was found in BU Seam-3, which was closely followed by IPSA Ssea-1 during winter. Individual pod weight was progressively decreased with every delay in planting in case of IPSA Seam-1 and BU Seam-3. Season did not, however, have significant influence on the single pod weight of JER. Winter crop of IPSA Seam-2 produced the heaviest pods but its early and late summer crops produced pods of similar weight.

It is evident that the pod size of IPSA Seam-1 and BU Seam-3 was identical although the earlier was significantly longer but narrower than the later. These two genotypes were superior in pod size to the other two genotypes. The genotype IPSA Seam-2 was, however, superior to JER in pod size, which was almost half the size of IPSA Seam-1. The largest pods were produced in winter. With each delay in planting pod size was greatly reduced. The pod size of winter beans was bigger than those of summer, early or late. Sawhney and Polowick (1985) stated that the tomato fruits produced in low temperature were larger than those in high temperature. The genotypes interacted greatly with the seasons in influencing the size of pods. The longest pods (12.65 cm) were obtained from IPSA Seam-1 in winter, which were significantly reduced to 10.99 cm in early summer and to 8.80 cm in late summer. The genotype BU Seam-3 had the thickest pods in winter, which was highly reduced with each delay in planting. The size of pods in IPSA Seam-2 was considerably decreased when planting was delayed up to early summer. Season did not influence on pod size of JER – a parent of the other three genotypes.

3.6.4. Number of seeds per pod

The genotypes differed from one another in respect of number of seeds per pod (Table 2). However, all seeds produced in a pod were not always good seeds. JER and IPSA Seam-2 were the best genotypes regarding quality or good seed production. In this respect IPSA Seam-1 was superior to BU Seam-3 but inferior to IPSA Seam-2. Every delay in planting was associated with an appreciable reduction in the number of seeds per pod, which was also significantly influenced by the interaction between genotype and season. Nevertheless, the genotypes except BU Seam-3 were identical in this respect when grown in winter or in early summer. In late summer, however, IPSA Seam-2 and JER produced identical but higher number of quality seeds than the two identical genotypes - IPSA Seam-1 and BU Seam-3 (the worst). Poor pollen production, lower pollen viability and growth of fewer pollen tubes through the style might be responsible for such lower number of seeds per pod in off-seasons. Uddin, (2003) reported that the abnormal anthers in late summer might not be able to produce adequate number of viable pollen grains for effective or compatible pollination and fertilization. Blackish brown or burning stigmas with no pollen grain or only a few pollen grains in late summer might also be responsible for providing with inadequate number of pollen grains for effective fertilization, indicating the receptivity of stigma which are reduced in off-season due to adverse effect of high temperature, relative humidity and rainfall. Zuberi and Sarker (1992) reported that seed yield in *Brassica* depends largely on the degree of pollen transfer, compatibility, fertility of the gametes, successful pollination and fertilization. Kuo *et al.* (1981) also reported drastic reduction in seed number after high temperatures at pollination due to poor pollen grain germination and pollen tube growth. Khan and Passam (1992) also reported that high day temperature caused progressive reduction of fruit weight and seed yield of sweet pepper.

3.6.5. Number of pods per plant

It is revealed from Table 2 that the number of pods per plant was influenced by genotypes, seasons and their interaction. The highest number of pods was produced by JER (706) and the lowest by BU Seam-3 (226.56), the difference being significant. IPSA Seam-1 and –2 produced identical number of pods, which were inferior to JER. Every delay in planting significantly decreased the number of pods per plant, which might be accounted for by poor pod set. The genotypes JER and IPSA Seam-1 produced the highest number of pods per plant in winter, with a considerably reduced number of pods in early and late summer. Although the number of pods per plant of BU Seam-3 was reduced with every delay in planting, the difference among the seasons was negligible. Every delay in planting almost halved the number of pods per plant in BU Seam-3 and JER.

3.6.6. Weight of 100 ripe seeds

The weight of 100 ripe seeds was influenced by genotypes and seasons. The highest weight of

100 ripe seeds was obtained from IPSA Seam-1 (31.66g) and the lowest from JER (20.87g). Every delay in planting reduced the weight of 100 ripe seeds. The genotype IPSA Seam-1 in winter produced the highest weight of 100 ripe seeds, which was reduced in early and late summer. In winter IPSA Seam-2 and BU Seam-3 produced identical weight of 100 ripe seeds, which were inferior to IPSA Seam-1 but superior to JER. Every delay in planting, however, significantly reduced the weight of 100 ripe seeds for all the genotypes.

3.6.7. Pod yield

The influence of genotypes, seasons and their interaction was significant in respect of pod yield (Table 2). The lowest amount of pod was found in JER (5.41 t/ha), which was similar to IPSA Seam-2 and BU Seam-3. The highest pod yield was recorded with IPSA Seam-1 (11.48 t/ha). Every delay in planting appreciably decreased the pod yield. Highest pod yield was obtained in winter (16.93 t/ha). Pod yield was drastically reduced in late summer (1.58 t/ha), which was, however, statistically identical with early summer even though the yield in late summer was half that in early summer. The extent of reduction in yield of the genotypes due to delay of planting from winter to early summer varied from 63 - 91% and to late summer it varied from 83 – 96%. This reduction in yield was due to the effect of temperature, humidity and rainfall on pollination, number of pods/plant, size and weight of individual pod. The genotype IPSA Seam-1 in winter produced the highest pod yield (30.70 t/ha) with a drastically reduced pod yield in early or late summer. The other three genotypes resulted in identical pod yield in winter, which were inferior to IPSA Seam-1. All the genotypes produced lower and identical pod yield during early and late summer. The influence of season on pod yield of all the genotypes, except IPSA Seam-1 was such that every delay in planting at least halved the pod yield per plant.

Figure 3 indicates that pollen viability, germinated pollen grain per stigma had positive association with pod yield. Poor pod yield in lablab bean during off-seasons in all the genotypes was possibly due to disturbance in embryological processes caused by unfavorable environmental factors.

4. Conclusions

It may be concluded that the genotypes differed significantly from one another regarding agronomic traits. Every delay in planting was associated with appreciable reduction in yield and yield contributing characters. This yield reduction due to delayed planting was accounted for by the detrimental influence of environmental factors like high temperature, high humidity and high rainfall on embryological traits which lead to reduce number of pod set, reduced pod size and reduced number of pods per inflorescence; and ultimately reduced pod yield. IPSA Seam-2 performed better in respect of all parameters irrespective of seasons. Photo-insensitive genotypes of lablab bean could be grown successfully during winter and early summer in Bangladesh.

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