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Phenology and productive performance of pigeon pea as influenced by date of sowing

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Abstract
A field experiment was conducted to study the physiological basis of variation in productivity of pigeon pea in relation to date of sowing at College of Agriculture, Raichur during kharif 2013-14. Significantly higher mean seed yield was recorded with early sown crop 10th July (2052.40 kg ha-1) over the late sown crop 1st (1290.01 kg ha-1) and 20th August (894.70 kg ha-1) and was mainly attributed more days to attain phenological stages viz., First branching (23.86 days), flower bud initiation (84.68 days), flower initiation (112.11 days), pod initiation (131.54 days), 50 per cent podding (150.88 days) and physiological maturity (165.87 days) coupled with longer duration of phenological phases viz;, first branching to flower bud initiation (61.89 days), flower bud initiation to flower bud initiation (28.56 days), flower initiation to pod initiation (19.59 days), pod initiation to 50 percent podding stage (19.43 days) and 50 per cent podding to physiological maturity (17.32 days). Among the genotypes studied, Cv. Asha recorded significantly higher seed yield (2117.33 kg ha-1) and the increased yield might be due to longer phenological phases coupled with more days to attain phenological stages as compare to all other genotypes

Keywords: Phenology, physiological maturity, flowering and pod initiation days

1. Introduction
Pigeonpea (*Cajanus Cajan* L. Mill sp.) is one of the most important leguminous perennial crop cultivated as annual in semi-arid tropical and subtropical regions. It is a common food grain and offers nutritional security due to its richness in protein (21 %) with essential amino acid such as methionine, lysine and tryptophan along with mineral supplementation *viz.*, iron and iodine. Abscission of leaves from plants and symbiotic nitrogen fixation improves soil fertility level and its deep strong root system makes it to Recognise as a "biological plough".

India has the distinction of being world's largest producer and consumer of pulses including pigeon pea. About 90 per cent (3.75 million hectare) of global pigeon pea area is in India, contributing to 90 per cent of production (3.1 Million tonnes) with productivity of (799 kg ha^{-1}) ranking ninth in the world and far below the global productivity (844 kg ha^{-1}). In Karnataka state pigeon pea occupies an area of about 5.96 lakh hectares and a production of 3.15 lakh tonnes, with an average productivity of 556 kg ha^{-1}. Gulbarga a potential district for extensive cultivation of pigeon pea in Hyderabad Karnataka region is being named as a 'Pigeon pea bowl' contributing 1.94 lakh tonnes from an area of 3.79 lakh hectare with a productivity of 539 kg ha^{-1} (Anon., 2013) [1]. One of the reasons for low productivity of pigeon pea seems to be terminal drought coincides with the critical phenological stages of growth *i.e.* flowering and grain filling. The timing of the crop cycle determines the crop productivity. Changes in crop phenology and its interaction with the changing environmental conditions were highlighted as a basis for formulating reliable adaptation policies. Hence In the present study the natural thermal variations for phenological phases were simulated by sowing the crop at different dates, to know the impact on phenology and performance of pigeon pea.

2. Material and Methods
The experiment was conducted during *kharif* season of 2013-14 at College of Agriculture, Raichur on black loamy soil. The trial was laid out in split plot design with three replication and three dates of sowing as a main plot *viz.*, 10th July, 1st and 20th August and four genotypes as a subplot *viz.*, BSMR-736, TS-3R, Asha and Maruti. The crop was raised as per recommended package of practices of UAS-Raichur and was adequately protected against pest and diseases. The Phonological observations like branching was recorded by summing the number of days taken from date of sowing to the appearance of first branch on 50 per cent of the plant population in each treatment and was expressed as branching stage in days. Number of days taken from date of sowing to the appearance of the first flower bud in each

treatment was recorded and expressed as days to flower bud initiation. The number of days taken from date of sowing to the appearance of the first flower in each treatment was computed and expressed as days to flower initiation in days. The number of days taken for appearance of pod initiation in each treatment was recorded and expressed as days to pod initiation in days. Ten plants were tagged in each subplot to record the days to 50 per cent podding stage. The number of days taken for 50 % podding of the plant (5 out of 10 plants) was recorded and expressed as days to 50% podding stage in days. Ten plants were tagged in each treatment to record this observation. The number of days taken by the plants to attain the 80 per cent of pod maturity were counted and recorded as days to physiological maturity stage. This stage is characterized by pods turning brownish in colour, completely ceasing of vegetative growth and plant parts starts drying. The crop growth period from first branching to the first flower bud initiation stage is computed for each treatment and was expressed as duration of the first branching – flower bud initiation in days. The crop growth period from flower bud initiation to flower initiation stage in each treatment was computed and expressed as duration of flower bud initiation– flower initiation in days. The crop growth period from flower initiation to pod initiation in each treatment was computed and expressed as duration of flower initiation - pod initiation in days. The crop growth period from pod initiation stage to the 50 per cent pudding stage in each treatment was computed and expressed duration of pod initiation stage - 50 per cent pudding in days. The crop growth period in days between 50 per cent pudding stage and physiological maturity stage in each treatment was computed and expressed 50 per cent pudding stage - physiological maturity stage.

3. Results and Discussion

The pigeon pea crop sown on July 10th recorded significantly higher mean of seed yield (2052.40 kg ha^{-1}) over the 1st (1290.01 kg ha^{-1}) and 20th August (894.70 kg ha^{-1}) sown crop (Table 1). Statistically higher seed yield with early sown crop may be ascribed to higher days to attain phonological stages coupled with longer duration of the phonological stages. These results are in good agreement with (Chandra *et al*. 1983) [3] who reported effect of sowing on grain yield in medium and late maturing varieties under rain fed conditions. The yield increases when sowing was taken up before July 15th and late sowing causes considerable reduction in yield due to photoperiodicity and excessive soil moisture stress which coincides with the reproductive growth. The difference in seed yield of pigeon pea varieties was also reported by Rabindranath reddy *et al.* (1997) [10], Puste and Jana (1996) [9], Padmavathy and Gurunatharao (1997) [8].

It is observed that 10th July sown crop recorded significantly more days to attain bud initiation (84.68), flower (112.11) pod (131.54), 50 % podding (150.88) and maturity (165.87). Over 1st and 10th August sowing. This may be due to the fact that, medium duration pigeon pea crop is photo period sensitive and exposure to favorable short day photoperiod makes plants to switch into reproductive phase more so with late sown crop. Hammerton, (1976) [5] who observed drastic reduction in number of days taken for flower bud, flowering, pod initiation, 50 per cent podding and physiological maturity of pigeonpea. The poor yield associated with delay in seedling date has been mainly due to the reduction in days to flowering, maturity and dry matter production. In the same way, yield variation in grain legume has been ascribed to interactive effect of morphological, physiological and or temporal traits during pre and post flowering periods with environmental factors was reported by Summerfield and Wein (1980.) Among the four genotypes studied, TS-3R, recorded significantly lesser days to attain various phenological stages and was may be due to its relatively short duration nature (141.75 days) as compare to Maruti (155.50 days), BSMR-736 (177.70 days) and Asha (178.78 days) which is seems to be its inherent character. Similarly, Bhat (1983) who observed drastic reduction in number of days taken for flower bud, flowering, pod initiation, 50 per cent podding and physiological maturity of pigeon pea. The poor yield associated with delay in seedling date has been mainly due to the reduction in days to flowering, maturity and dry matter production.

In pigeon pea not only days to attain phonological stages but phonological phase (duration) also play important role in its productivity. Generally, longer crop duration is associated with more dry matter accumulation and in turn is associated with the higher seed yield. The data on duration of phonological phases *viz.*, early sown crop (10th July) recorded significantly maximum duration for first branching to flower bud initiation stage (61.75 days) over 1st and 20th August sowing. The medium duration pigeon pea genotypes are short day plant in nature and there a hastening of bud initiation in response to day length and is more so with 20th August sowing. In the present study, the numerical variations in duration of grain filling was observed due to genotypes and date of sowing interactions and was in response to terminal moisture stress and the temperature variation that might have forced the crop to complete the life cycle and is expressed in numerical variations in duration of (3.52 days) phenological phases. The results are in agreement with the findings of Dahiya, *et al*. (1974) [4] and Kaul and Sekhon (1975) [7] who reported reduced grain filling duration pigeonpea in late sown crop due to moisture stress.

4. Conclusion

Based on the results of the present investigation, in order to realise potential yield of pigeon pea early sowing may be practiced as yield largely influenced by crop duration. Pigeon pea crop is photo period sensitive and exposure to favorable short day photoperiod makes plants to switch into reproductive phase with late sown crop resulting poor yield. Sowing of pigeon pea, should be done June or July month at the onset of the monsoon sowing of pigeon pea is done. Late sowing causes considerable reduction in yield. Because the fluctuation in day and night temperature during reproductive phase might be responsible for inducing more flowers shedding which adversely affects yield potential of the crop. Among the genotypes cv. Asha recorded highest yield even under late sowing situation may be ascribed to long duration of the crop

Table 1: Seed yield and days to attain phenological stages of pigeonpea as influenced by date of sowing

Parameters	Grain Yield (Kg.ha$^{-1)}$	First branching (days)	Flower bud initiation (Days)	Flower initiation (Days	Pod initiation (Days)	50 per cent podding (Days)	Physiological maturity (Days)
Date Of Sowing							
10 July	2052.40	2052.40	84.68	112.11	131.54	150.88	165.87
1st August	1290.01	1290.01	78.61	105.03	123.33	141.29	163.10
20th August	894.70	894.70	76.43	102.01	119.63	139.29	161.07
S.Em (±)	37.71	1.22	1.14	1.56	1.53	0.99	1.56
C.D @ 5 %	123.54	NS	4.47	6.15	6.17	3.92	6.15
Genotypes							
BSMR-736	1482.51	22.57	81.52	111.82	134.41	158.61	177.70
TS-3R	1087.50	23.33	70.26	84.57	102.48	121.74	141.75
Asha	1670.14	23.41	88.49	118.21	121.62	154.77	178.78
Maruti	1409.34	23.68	79.42	110.89	126.69	139.62	155.19
S.Em (±)	57.39	0.47	1.11	1.08	1.26	1.12	1.78
C.D @ 5 %	170.36	NS	3.29	NS	3.60	3.33	5.27

Note: DS_1= First date of sowing (10th July, 2013), DS_2= Second date of sowing (1st August, 2013), DS_3=Third date of sowing (20th August, 2013)

Table 2: Duration of phenological phases (days) of pigeonpea as influenced by date of sowing

Parameters	First branching to flower bud initiation	Flower bud initiation to flower initiation	Flower initiation to pod initiation	Pod initiation to 50 per cent podding	50 per cent podding to physiological maturity
Date Of Sowing					
10 July	61.89	28.56	19.59	19.43	17.41
1st August	55.34	26.67	18.78	17.98	17.13
20th August	52.98	25.15	17.89	15.34	12.32
S.Em (±)	1.63	1.65	0.89	1.03	0.56
C.D @ 5 %	6.42	NS	NS	NS	
Genotypes					
BSMR-736	59.38	30.43	22.67	20.41	18.17
TS-3R	46.79	14.12	17.89	19.45	15.94
Asha	65.23	30.46	18.12	16.78	19.24
Maruti	55.76	31.47	15.56	13.23	15.84
S.Em (±)	1.15	1.51	0.98	0.78	0.76
C.D @ 5 %	3.43	4.48	2.93	2.32	2.26

Note: DS_1= First date of sowing (10th July, 2013), DS_2= Second date of sowing (1st August, 2013), DS_3=Third date of sowing (20th August, 2013)

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