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Effects of date of sowing on source sink relation in pigeonpea

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Abstract
A field trial was laid out in split plot design with tree replications 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 sown on 10th July recorded 62 and 69 per cent higher seed yield over crop sown on 1st and 20 th August, respectively. The higher mean yield of 10 th July early sown crop may be ascribed to improved sink capacity and was evident from increased pod number, pod weight, 100seed weight, seeds per pod, flower production, peduncles and harvest index. The higher sink capacity of early sown crop can be traced back to higher mean value of source parameters viz;, Leaf area, Leaf are duration, Total dry matter, leaf dry matter, and chlorophyll content which are pre requisite for better productivity of the crop. Interestingly, early sown crop (10th July) also recorded not only significantly higher flower production, but also higher pod drop, flower drop and higher leaf drop over late sown crop. Among the genotypes studied, cv. Asha recorded, 11.25, 22.85 and 15.62 per cent more seed yield over BSMR-736, TS-3R and Maruti, respectively.

Keywords: Effects, date, sowing, source sink relation in pigeonpea

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. It has been recognized as a biological plough due to the fact that it improves soil fertility through symbiotic nitrogen fixation and Abscission of leaves from plants

India has the distinction of being world's largest producer and consumer of pulses particularly pigeonpea. About 90 per cent (3.75 million hectare) of global pigeonpea area is in India, contributing to 90 per cent of production (3.1 Million tonnes) with productivity of 799 kg ha^{-1}. The productivity of Pigeonpea in northern Karnataka which is called as a Dal Bowl of Karnataka is far below (539kg/ha) than the state average (556kg/ha), national average (799kg/ha) and world average (844 kg/ha.) (Anon., 2015) [1]. One of the reasons for low productivity of pigeonpea seems to be imbalanced source sink relationship which determines the crop productivity. The indeterminate and short day plant nature of pigeonpea causing inter organ competition for metabolites and photosynthates. As a result absicission of flowers, leaves and pods is being noticed which causes low fruiting and low partitioning coefficient (HI), consequently lowering over all yield and quality. Source and sink and their interaction with the changing environmental conditions were seems to be basis for crop sustainability and more so with changing climate scenario. Hence, in the present study the natural variations in source and sink were simulated by sowing the crop at different dates, to know its impact on the performance of Pigeonpea.

Material and Methods
A field experiment was conducted during *kharif* - 2013-14 at College of Agriculture, Raichur on black loamy soil. The trial was laid out in split plot design with tree replications 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 fully developed pods were separated from five plants and were counted and the average was taken as number of pods per plant and was expressed as pods per unit areas. Further the pods were weighed separately on analytical balance and average of mean pod weight expressed in g $plant^{-1}$. Seed samples of 100 seeds were collected from the produce of each treatment separately and weight of 100 seeds was expressed as test weight in grams. Five plants were uprooted at randomly in boarder rows of each treatment and partitioned into stem, leaf and reproductive parts. These samples were oven

Dried at 70 °C in hot air oven for 48 hours till a constant weight. The total dry matter production per plant was obtained with the summation of dry weight of all plant parts and was expressed on per plant basis (g plant^{-1}). The net plot area as per the treatment was harvested by cutting the plants close to the ground. After harvesting, the plants were bundled and allowed for sun drying. After complete sun drying, the plants were threshed by beating with wooden sticks. The seeds were winnowed, cleaned and seed weight per net plot was recorded and was expressed as grain yield quintals ha^{-1}.The leaf area per plant (LA) was worked out by disc method on dry weight basis as per the Vivekanandan *et al.* (1972) [9]. It was expressed as (dm^2 plant^{-1}) Leaf area duration (LAD) is the integral of leaf area index (LAI) over the growth period and was calculated and expressed in days. Total chlorophyll content of the leaves was determined by following dimethyl sulfoxide (DMSO) method as devised by Hiscox and Israeistam (1979) and was expressed as g plant-1 fresh leaf weight per plant. Plastic trays of size 90*90 cm were placed between rows in each treatment. Abscised leaves, flowers and pods, were collected in trays and were counted at three days interval regularly till crop maturity. The dry weight of dropped leaves was recorded. The leaf abscission was expressed as g per unit area. Whereas, flower and pod drop were expressed as number of flower and pod drop per unit area. Fully developed pods were separated from five plants and were counted and the average. was taken as the number of pods per plant and was expressed as pods per unit area and also its weight as Pod weight per plant (g plant^{-1}).The seeds from ten representative pods were separated, counted and the mean number of seeds per pod was calculated by dividing the number of seeds by the number of pods.

Results and discussion

Yield is the most important and complex trait in crops and is directly influenced by source and sink relation in plants. Significantly higher seed yield of 2052.40 kg ha^{-1} was obtained with crop sown on 10 th July over 1st (1290.01 kgha^{-1}) and 20 th August (894.70 kg ha^{-1}) sown crop.. The Pigeonpea crop sown on 10 th July recorded 62 and 69 per cent higher seed yield over crop sown on 1th and 20 th August, respectively. The higher mean yield of 10 th July early sown crop may be ascribed to higher mean value of pods per m^2 (1881.1 m^2 area), pod weight1 (162.46 g plant^{-1}) test weight (10.87 g) and seeds per pod (3.21), flower production (8210 m^2 area), peduncles (411 plant^{-1}) and harvest index(25.15%),indicating the improvement in sink capacity. This higher sink capacity of early sown crop can be traced back to higher mean value of source parameters viz;, Leaf area (73.23 dm2 plant^{-1}), LAD (630.5 days),TDM(237.75g plant^{-1}) and leaf dry matter (41.6g plant^{-1}) and chlorophyll content (171.7mg plant$^{-1)}$. These parameters represents Photosynthetically active surface area (LA), longer period of Photosynthatically active surface area (LAD) quantum of pigment involved in photosynthesis and efficient accumulation of photosynthets in vegetative sink parts (TDM and Leaf dry matter), which are pre requisite for higher productivity of the crop. Hence, efficient source might be the cause for improved sink capacity. On contrary, The higher leaf drop (20.93g plant$^{-1)}$ in early 10th July sown crop may be attributed to more leaf foliage production (45.61 g plant$^{-1,}$ Leaf dry matter) and higher sink capacity coupled with shading of lower leaves due to dense plant architecture. (branching and LA).,in addition to shorter life of the upper young leaves due to nutrient drain to developing pods and enhanced ageing of lower canopy leaves due to shading. The results are in agreement with findings of Patel *et al.* (1983) [6]. Interestingly, early sown crop (10 th July) recorded significantly higher flower production (1881.1 m^2 area) followed by higher pod drop (46.9 m^2 area) flower drop (5976 m^2 area) over late sown crop. The increased production of flowers may be ascribed to more dry matter production due to longer growth phase as pigeonpea is a short day plant where in late sown crop is forced to enter reproductive growth sooner exposed to short day condition as a result the vegetative growth phase is shortened under late sowing and was expressed in terms of reduced dry matter accumulation. On contrary higher flower drop may be attributed to the compensatory mechanism of maintaining the flower setting depending on the source. These results are in accordance with the Pandey (1980) [4] who reported that higher flower drop under late sown condition could be either is attributed for low leaf area (lower assimilation availability) or to lower assimilation rate. Further, reported that flower drop due to non-availability of assimilates and confirmed by positive association of dry matter allocation on stem, leaf and root with flower drop under normal seedling. Pigeonpea prefer to have more vegetative growth by diverting carbon assimilation to the vegetative parts and thus depriving the flowers. Similarly, Sheldrake and Narayanan (1979) [8] reported that Pigeon pea set fewer pod because the pod do not set when assimilates supply falls below threshold. Among the genotypes, the cv. Asha produced significantly higher seed yield (1670.14 kg ha-1) followed by BSMR-736 (1482.51 kg ha-1), over Maruti (1409.34 kg ha-1) and TS-3R (1087.50 kg ha-1). The extent of increase in seed yield of Asha was 11.25, 22.85 and 15.62 per cent over BSMR-736, TS-3R and Maruti, respectively. The increased mean yield of cv. Asha may be attributed to higher sink capacity viz;, pods number,(1530.1 plant^{-1}) pod weight(139.72 plant^{-1}), test weight(10.76 g per 100seeds) and seeds per pods (3.15) etc, coupled with higher mean values of source parameters vz; Leaf area (65.79dm^2 plant$^{-1)}$, LAD (542.1days) leaf dry matter (37.45g plant$^{-1)}$, chlorophyll content (140.1mg plant^{-1}) and TDM (189.14 g. plant$^{-1)}$ Interestingly, cv. Asha recorded significantly more production of flowers (6888 m^2 area), flower drop(4833 m^2 area) and also pod drop (40.02 m^2 area)as compare to other genotypes. In similar way the difference in seed yield of Pigeonpea varieties was also reported by Ravindranathreddy *et al.* (1997) [7] in Tur, Puste and Jana (1996) in Tur, and Padmalatha and Gurunatharao (1997) [3] in Tur. The increased production of flowers may be ascribed to more dry matter production due to longer growth phase. On contrary higher flower drop and pod drop may be attributed to the compensatory mechanism of maintaining the flower setting depending on the source. Further, genotypic variation revealed, cv.Asha recorded significantly higher abscission of leaf material followed by BSMR-736 over Maruti and TS-3R. The results are in agreement with findings of Patel *et al.* (1983) [6]. These results are in good agreement with (Chandra *et al*. 1983) 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.

Conclusion

Based on the results of the present investigation, in order to realize potential yield of pigeonpea early sowing may be practiced as yield largely influenced by crop duration. Pigeonpea 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. Early sowing soon after onset of monsoon may be practiced to realize potential yield.

Table 1: Seed yield and potential source of Pigeonpea at flowering stage as influenced by date of sowing

Date of sowing	Seed yield (kg ha^{-1})	Leaf area (dm^2 plant^{-1})	Leaf dr Matter (g plant^{-1})	Leaf area duration (days)	Total dry matter, (g plant^{-1})	Peduncle (g plant^{-1})	Chlorophyll (mg. plant^{-1})	Abscission of Leaf (g.m^2)
10th July	2052.40	73.23	41.16	630.5	237.75	411	171.7	20.93
1st August	1290.01	56.50	32.31	428.5	165.63	259	133.1	13.75
20th August	0894.70	46.57	25.81	326.2	92.29	156	95.45	10.08
S.Em (±)	37.71	0.84	0.58	8.1	1.21	20.00	2.19	0.68
C.D @ 5%	123.53	3.32	2.29	31.8	4.75	79.00	NS	2.54
Genotype						332		
BSMR-736	1482.51	64.36	35.115	519.9	186.32	332	144.0	17.59
TS-3R	1087.50	53.30	28.36	367.1	118.62	203	129.4	13.21
Asha	1670.14	65.79	37.45	542.1	189.14	336	140.1	19.18
Maruti	1409.34	51.59	30.48	417.6	166.53	230	120.4	14.73
S.Em (±)	57.39	1.29	0.74	7.2	1.75	20	4.57	0.73
C.D @ 5%	170.36	3.83	2.22	21.6	5.20	60	NS	2.28

Table 2: Yield parameters and potential sink of pigeonpea as influenced by date of sowing

Date of sowing	Number of Flower production (m^2)	Number of pods production (m^2)	Number of Flower drop(m^2)	Number of Pod drop (m^2)	Number of Seeds pod^{-1}	100 seed weight (g)	Pod weight (g. plant^{-1})
10th July	8210	1881.1	5972	46.9	3.21	10.87	162.46
1st August	5692	1423.4	4232	34.59	3.13	10.11	119.28
20th August	3423	699.4	2496	23.64	3.12	9.21	84.25
S.Em (±)	128	34.5	106	0.58	0.03	0.71	4.40
C.D @ 5%	502	136.2	417	2.25	Ns	NS	17.30
Genotype							
BSMR-736	6402	1530.1	4755	37.98	3.21	9.51	135.88
TS-3R	4072	1002.1	2956	28.41	3.17	10.08	93.70
Asha	6888	1642.6	4833	40.02	3.15	10.76	139.72
Maruti	5743	1043.2	4263	33.86	3.23	9.21	116.75
S.Em (±)	162	39.70	127	1.51	0.04	0.62	2.81
C.D @ 5%	481	118.3	378	4.49	ns	NS	8.33

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