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Assessment of promising lines of chickpea for variation in Phenological development and yield attributes under late sown condition

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Abstract
The present research investigation was conducted during Rabi season 2017 at Research Farm, AICRP on chickpea, Department of Plant Breeding and Genetics, JNKVV, Jabalpur (M.P.). The research experiment was laid out in a Randomized Block Design with three replication and treatment comprised of 20 Chickpea genotypes evaluated under two dates of sowing. The various genotypes expressed a significant variability among themselves in relation to their phenological development and yield attributes of Chickpea under normal (November) and late (January) sown conditions. The high temperature had a strong influence on almost all the parameters of yield in chickpea genotypes under investigation. Under late sown (January) the genotypes flowered (1-5 days) earlier than the normal sown (November) conditions. This earliness was also noted in attaining most of other phenological stages in late sown condition due to enhanced temperature. Genotypes G19, G13 and G9 required lesser time for initiation of first flower and attainment of general flowering, pod initiation and physiological maturity under both normal and late sown conditions.

Keywords: chickpea, Phenological development and yield

Introduction
Chickpea (*Cicerarietinum* L.) commonly known as 'Bengal gram or garbanzo' is the third most important food legume globally, is grown on over 10 m ha across 51 countries (FAOSTAT, 2007) from equatorial tropics to the temperate northern latitudes (500N) and the seed is a major source of plant-based dietary protein, carbohydrates and minerals especially for the human. India is the largest producer contributing to 65% of world's chickpea production. Chickpea can fix up to 140 kg nitrogen ha-1 and meet up to 80% of its nitrogen requirement from symbiotic nitrogen fixation (Saraf *et al*., 1998) [9]. It leaves behind a substantial amount of nitrogen through crop residue for subsequent crops and adds much needed organic matter to maintain and improve soil health, long-term fertility and sustainability of the ecosystems. According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) chickpea seeds contain on average- 23% protein, 64% total carbohydrates (47% starch,6% soluble sugar), 5% fat, 6% crude fiber and 3% ash. Phenology (time to flowering, pod ding and maturity) plays critical role in adaptation of chickpea cultivars to different environments (Berger *et al*., 2004, 2006) [1, 2]. Early phenology is a key trait for adaptation of chickpea to short-season environments as it helps crop to escape from end-of-season stresses (drought, temperature extremities). The chickpea grain yield is related to its phenology which is influenced by temperature. The timing and duration of flowering has an important role in determining crop duration and grain yield at high temperature. The crop is forced into maturity under hot and dry condition (>30 ºC) by reducing the crop duration (Summerfield *et al*. 1984) [8].

Material and methods
In the present investigation, 20 Chickpea genotypes evaluated under two dates of sowing were used to estimate the phenological development and yield attributes under two dates of sowing condition. The experiment was at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur (MP) under Research Farm, AICRP on chickpea Project in randomized complete block design with three replications.

Result and Discussion
Days to first flower initiation showed (Table 1) that genotypes G19 (34.67), G13 (35.33) and G9 (35.67) were the earliest. Whereas, G17 (52 days) took significantly more days for days to 1st flowering among other genotypes and were differed significantly among each other under

normal sown condition However, under late sown condition G13 (26.33 days) required the minimum days for 1st flowering followed by G9 (28 days) which differed significantly with other genotypes. Genotype 17(39.67 days) took maximum days for 1st flower initiation. These results corroborate with the finding of (Jirali *et al*. 1988) [5]. They conclude that the chickpea genotypes which produce maximum number of flowers 25 days after flower initiation produced the maximum yield. Days to 50% flowering showed that genotypes G19 (45.67), G13 (46.33) and G9 (46.67) were the earliest. Whereas, G17 (63 days) took significantly more days for days to 50% flowering among other genotypes and were differed significantly among each other under normal sown condition However, under late sown condition G13 (41.33 days) required the minimum days for 50% flowering followed by G9 (43 days) which differed significantly with other genotypes. Genotype 17(54.67 days) took maximum days for 50% flowering. Berger *et al*., (2004) [1] studied in chickpea, reduces the time interval between 50% flowering and pod ding. Noticed that early flowering was associated with high harvest index, large number of pods and high seed yield. Days to pod initiation showed that genotypes G19 (58.67), took earliest pod initiation at par with G13 (59.33). Whereas, G17 (76 days) took significantly more days for days to 1stflowering among other genotypes and were differed significantly among each other under normal sown condition However, under late sown condition G13 (26.33 days) required the minimum days for pod initiation followed by G9 (28 days) which differed significantly with other genotypes. Genotype 17(39.67 days) took maximum days for pod initiation. Ram *et al*. (2006) comprehensively studied the temperature and photoperiod effect on pea. They reported that high temperature during the reproductive phase significantly reduces the flowering time and after that time the flower initiation is completed and no formation of pods in plants. Days to completion of flowering showed that genotypes G19 (79.67), took earliest days to completion of flowering at par with G13 (89). Whereas, G17 (94 days) took significantly more days for days to completion of flowering among other genotypes and were differed significantly among each other under normal sown condition However, under late sown condition G9 (60 days) required the minimum days for days to completion of flowering followed by G7 (61 days) which differed significantly with other genotypes. Genotype 13(70days) took maximum days to completion of flowering. A threshold day/ night temperature for chickpea growth and reproductive development is between 29/21 °C and 21/15 °C. Early flowering is a key factor in the formation and maturation of pods before the occurrence of these abiotic stresses. Kumar and Abbo (2001) [6] have reported that time to flowering plays a central role in determining the adaptation and productivity of this crop in short growing environments. Days to flowering period showed that genotypes G10 (41.33), took earliest days to completion of flowering period at par with G15 & G5 (41.67). Whereas, G13 (53.67 days) took significantly more days for days to completion of flowering among other genotypes and were differed significantly among each other under normal sown condition. However, under late sown condition G19 (26.67 days) required the minimum days for days to completion of flowering followed by G17 (27 days) which differed significantly with other genotypes. Genotype 13 (43.67 days) took maximum days to completion of flowering. Heat stress (≥ 35 °C during flowering and pod development) results in severe yield losses due to the impact of high temperatures on different physiological processes. The timing and duration of flowering has an important role in determining crop duration and grain yield at high temperature. The crop is forced into maturity under hot and dry condition (>30 ºC) by reducing the crop duration (Summerfield *et al* 1984) [8]. Days to physiological maturity showed that genotypes G19 (102.67), took earliest days to completion of physiological maturity at par with G13 & G9 (103.33, 103.67). Whereas, G17 (120 days) took significantly more days for days to completion of physiological maturity among other geno types and were differed significantly among each other under normal sown condition. However, under late sown condition G9& G5 (71 days) required the minimum days for days to completion of physiological maturity followed by G19 & G7 (72days) which differed significantly with other genotypes. Genotype G13 (81) took maximum days to completion of physiological maturity. Stated that water deficits influenced on phenology, growth and dry matter allocation in chickpea. Durations of emergence to flowering (E-FL), flowering to beginning of pod-filling (FL-BPF), and beginning of pod-filling to physiological maturity (BPF-PM) were inversely correlated with normalized evapotranspiration deficit (E_t- deficit) experienced by the crop during a growth period. Days to physiological maturity showed that genotypes G19 (107.67), took earliest days to completion of physiological maturity at par with G13 & G9 (109.67). Whereas, G17 (124 days) took significantly more days for days to completion of physiological maturity among other genotypes and were differed significantly among each other under normal sown condition. However, under late sown condition G5 (75 days) required the minimum days for days to completion of physiological maturity followed by G7 (76 days) which differed significantly with other genotypes. Genotype G13 (85) took maximum days to completion of physiological maturity. Evaluated chickpea genotype for seed yield and its components (days to 50% flowering, days to maturity, plant height, primary branches per plant, pods per plant and 100-seed weight) under normal (non stressed and late (stressed) condition.G_{13} exhibited the highest grain yield per hactare (3388.00) value followed by G_{12} (3003.70), and G_{17} (2886.10) and lowest value of grain yield per hectare (981.40) was noted in G_6 under normal sown condition (Table 4.5.9 and Figure 54).However, under late sown condition G_{13} (1856.07), G_{12} (1614.07) and G_{17} (1515.07) recorded maximum grain yield per hectare and were done not varied significantly among them and significantly superior with the remaining genotypes. Minimum grain yield per hectare was obtained by G_4 (485.47). Choudhary *et al*. (1989) [3] studies that, morphological characters like height, yield components, biomass and harvest index played dominating role in regulating seed yield in chickpea. Further, they noticed positive correlation of seed yield with height number of pods, biological yield and harvest index.G_{13} exhibited the highest biological yield per hectare (11336.67) value followed by G_{12} (9683.33), and G_{17} (9099.33) and lowest value of biological yield per hectare(2416.33) was noted in G_6 under normal sown condition. However, under late sown condition G_{13} (5580.70), G_{12} (4986.70) and G_{17} (4800.70) recorded maximum biological yield per hectare and were done not varied significantly among them and significantly superior with the remaining genotypes. Minimum biological yield per hectare was obtained by G14 (1621.70). Observed that physiological traits (RWC, MII and chlorophyll content) were closely associated with growth parameters (RGR, NAR and LAI), consequently higher. Biomass production which is a prerequisite for any successful genotype under rainfed environment.

Table 1: Variation in Phenological traits of chickpea genotypes under normal and late sown conditions

Genotypes	Days to 1st flower initiation		Days to 50% flowering		Days to pod initiation		Days to completion of flowering		Flowering period		Days to Physiological maturity		Grain yield (kg ha^{-1})		Biological yield (kg ha^{-1})	
	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.	N.S.	L.S.
G1	38.33	35.00	49.33	50.00	62.33	56.00	79.67	66	41.33	31.00	106.33	77.00	1430.80	1145.47	3526.33	4016.70
G2	39.00	32.33	50.00	47.33	63.00	53.33	81.00	63	42.00	30.67	107.00	74.00	1966.30	934.27	6571.33	3510.70
G3	40.00	35.33	51.00	50.33	64.00	56.33	82.00	65	42.00	29.67	108.00	76.00	2010.40	720.87	5679.72	2963.70
G4	45.00	29.67	56.00	44.67	69.00	50.67	88.00	62	43.00	32.33	113.00	73.00	2392.60	485.47	8375.33	2307.70
G5	38.33	28.00	49.33	43.00	62.33	49.00	80.00	60	41.67	32.00	106.33	71.00	2531.20	839.67	6502.33	3215.70
G6	45.67	30.00	56.67	45.00	69.67	51.00	88.00	62	42.33	32.00	113.67	73.00	981.40	916.67	2416.33	3500.70
G7	38.00	33.00	49.00	48.00	62.00	54.00	80.67	61	42.67	28.00	106.00	72.00	1445.50	1347.87	3687.33	4579.70
G8	36.00	29.00	47.00	44.00	60.00	50.00	79.00	63	43.00	34.00	104.00	74.00	1708.00	1123.47	6675.33	4030.70
G9	35.67	28.00	46.67	43.00	59.67	49.00	78.67	60	43.00	32.00	103.67	71.00	1918.00	929.87	4941.33	3409.70
G10	50.67	36.33	61.67	51.33	74.67	57.33	92.00	68	41.33	31.67	118.67	79.00	2558.50	676.87	6519.33	2891.70
G11	37.67	30.33	48.67	45.33	61.67	51.33	79.67	63	42.00	32.67	105.67	74.00	2671.90	1002.47	8386.33	3628.70
G12	39.67	31.33	50.67	46.33	63.67	52.33	81.67	65	42.00	33.67	107.67	76.00	3003.70	1614.07	9683.33	4986.70
G13	35.33	26.33	46.33	41.33	59.33	47.33	89.00	70	53.67	43.67	103.33	81.00	3388.00	1856.07	11336.67	5580.70
G14	38.33	35.67	49.33	50.67	62.33	56.67	81.00	63	42.67	27.33	106.33	74.00	2079.70	507.47	5373.33	2021.70
G15	50.00	35.33	61.00	50.33	74.00	56.33	91.67	63	41.67	27.67	118.00	74.00	1426.60	1132.27	3672.33	4062.70
G16	41.00	33.67	52.00	48.67	65.00	54.67	84.00	65	43.00	31.33	109.00	76.00	2396.80	1083.87	6186.33	3889.70
G17	52.00	39.67	63.00	54.67	76.00	60.67	94.00	67	42.00	27.33	120.00	78.00	2886.10	1515.07	9099.33	4800.70
G18	48.67	38.00	59.67	53.00	72.67	59.00	91.67	66	43.00	28.00	116.67	77.00	1628.20	907.87	4155.33	3413.70
G19	34.67	34.33	45.67	49.33	58.67	55.33	79.67	61	45.00	26.67	102.67	72.00	1313.20	1108.07	6153.33	3926.70
G20	47.33	34.00	58.33	49.00	71.33	55.00	89.67	62	42.33	28.00	115.33	73.00	1157.80	1046.47	5637.33	3755.70
Mean	41.57	32.77	52.57	47.77	62.08	50.43	84.55	63.62	42.98	13.45	109.57	74.75	1908.59	710.89	6228.92	3704.70
SEm±	0.60		0.60	0.55	0.43	0.55	0.60	0.41	0.86	1.21	0.60	0.26	20.84	29.01	35.46	0.32
CD (5%)	1.72	1.57	1.72	1.57	1.22	1.58	1.72	1.18	2.45	3.47	1.72	0.74	59.68	83.05	101.53	0.97

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