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Shweta Tiwari
Department of Agronomy, College of Agriculture Indore, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India

HS Thakur
Department of Agronomy, College of Agriculture Indore, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India

OP Girothia
Department of Agronomy, College of Agriculture Indore, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India

Correspondence
Shweta Tiwari
Department of Agronomy, College of Agriculture Indore, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India

Effect of moisture stress and Non stress condition on phenological character for draught tolerance of different chickpea (*Cicer arietinum* L.) varieties

Shweta Tiwari, HS Thakur and OP Girothia

Abstract
In order to study the effect of moisture stress and non stress condition on phenological character of nine cultivars of Chickpea (*Cicer arietinum* L.), an experiment consisted of 27 treatment combinations comprising three moisture stress condition *viz*. S0 (Non stress condition), S6L (Water withheld from 6 leaf stage) and SFL(Water withheld from flowering) in main-plots and 9 chickpea varieties *viz*. Ujjain-21, JAKI-9218, IG-593, JG-6, JG-16, JG-130, JG-412, JG-11 and KAK-2 in sub-plots. Experiment laid out in split plot design with three replications. Moisture stress condition S_{6L} (Water withheld from 6 leaf stage) registered significantly lowest values of days to flower initiation, days to 50% flowering, days to pod initiation and days to physiological maturity and the length of reproductive phase. Chickpea variety, KAK- 2 noted the significantly least values of days to flower initiation, days to 50% flowering, days to pod initiation and physiological maturity. Which is found tolerance to moisture stress.

Keywords: Chickpea varieties, moisture stress, phenological character, drought tolerance

Introduction
Pulse grains are an essential part of the daily diet for people in many developing countries where a larger proportion of the population cannot afford animal products (Mike, 1988). Chickpea (*Cicer arietinum* L.) is the second most important pulse crop in the world, grown over 42 countries in South Asia, West Asia, North Africa, East Africa, Southern Europe, North and South America, Australia (Singh, 1997) [7]. Besides its role in reducing the gap in protein nutrition of cereal-dominated diets in developing countries, it provides high quality feed for livestock. Moreover, as a legume, its cultivation fits well in cereal-cereal or cereal-fallow rotation systems where it contributes to the system sustainability and reduces the need for nitrogen fertilizer. Chickpea is the most important pulse crop in India, accounts for approximately 75% of world's chickpea production. It occupies an area of 8 mha and its production is 7.1 mt with an average productivity of 885 kg·ha−1 (Economic survey 2009-2010). Despite the high total production, yields of chickpea are low due to drought. Drought is one of the most important factor which limit the productivity of rainfed chickpea in the Mediterranean environments of West Asia and North Africa (Smith and Harris, 1981) [8]. Chickpeas yield losses due to inadequate soil moisture availability, varies between 36 and 42% depending on geographic location and climatic condition during the crop season (Saxena *et al*., 1993) [6]. The type of drought stress, which affects cool season food legumes, including chickpeas are: an intermittent drought stress caused by breaks in winter rainfall, and terminal drought stress, resulting from receding soil moisture. Early flowering types will lead, therefore, to cultivars with short seed filling duration which, however, may suffer a yield reduction in years when soil moisture condition are above average. It is, therefore, important to investigate the possibility of identifying chickpea genotypes early in flowering but with a prolonged seed filling period as well as a high rate of seed filling, that will allow yield stability and can escape the late season soil moisture stress. The objective of this experiment was to evaluate phonological traits in nine chickpea varieties, with the aim of identifying those avoid drought.

Materials and Methods
A field experiment was conducted during rabi 2014-15 at college of agriculture, Indore, on medium black soil (Vertisols), having 7.88 pH, 0.45% organic carbon, 232 kgha-1 available

nitrogen, 10.2 kgha-1 available phosphorus and 540 kgha-1 available potassium. The topography of the experimental area was fairly leveled. Indore is situated in Malwa Plateau in western parts of Madhya Pradesh on 22º43'N latitude and 75º66'E longitude with an altitude of 555.5 m above the mean sea level. This region enjoys sub tropical semi arid type climate with an average annual rainfall of 964 mm, most of which is received during mid June to middle of September. Southwest monsoon is responsible for major part of the precipitation with occasional showers in winter. The mean minimum and maximum temperature ranges between 7ºC–23ºC and 23ºC–43ºC, respectively. December and January are the coldest months. In summer, the maximum temperature seldom goes beyond 41.7ºC in the month of May. The soil of the experimental field has been grouped under medium black (Vertisols), belonging to fine montmorillonite hyperthermic family of typical chromusterts predominantly clayey in texture. The surface soil samples (0-30 cm) were collected randomly with the help of soil auger before sowing from the experimental field and representative composite sample was made for the mechanical and chemical analysis. The field experiment was carried out in split plot design with twenty seven treatment combinations of three moisture stress situation in main plot and 9 chickpea varieties in sub plots in three replications. Crop was irrigated as per the treatments.

The details of irrigation are given below –

S_{6L} -Pre-sowing irrigation only

S_{FL} - Irrigations at pre-sowing and 35 DAS crop stage

S_0- Irrigations at pre-sowing,

20 and 35 DAS crop stage

Observations

1. **Days to initiation flowering:** This observation was recorded visually. When first flower in each plot was seen, the date was noted.
2. **Days to 50% flowering:** This observation was recorded visually. When about half of plant population flowered, the date was noted.
3. **Days to pod initiation:** This observation was recorded visually. When first pod in each plot was seen, the date was noted
4. **Days to physiological maturity:** This observation was recorded visually. When about half of pods turned yellow and plants showed physiological maturity, the date was noted.
5. **Length of reproductive phase:** On the basis of flower initiation number of days to physiological maturity, length of reproductive phase were calculated and recorded in each treatment plot.

Results and Discussion

The data summarized in table (1) revels that there is a various phonological parameters like days to flower initiation, days to 50% flowering, days to pod initiation, days to physiological maturity and length of reproductive phase show clear trend**.** Moisture stress condition S_{6L} (Water withheld from 6 leaf stage) registered significantly lowest values of days to flower initiation, days to 50% flowering, days to pod initiation and days to physiological maturity and the length of reproductive phase. The highest values of days to flower initiation, days to 50% flowering, days to pod initiation, days to physiological maturity and length of reproductive phase were found to be associated with S_0 (Non stress condition). Soil moisture stresses enhance early senescence and maturation of chickpea, maturity was hastened by 4-5 days. Saxena and Sheldrake (1979) [5] and Mhase *et. al.*, (2003) [2] also reported similar findings.

Chickpea variety, KAK- 2 noted the significantly least values of days to flower initiation, days to 50% flowering, days to pod initiation and physiological maturity. The highest values of days to flower initiation were found to be associated with JG- 16 followed by IG -593. For days to 50 % flowering and days to pod initiation highest value recorded in JG-16 followed by JG-6. Days to physiological maturity was recorded significantly higher under IG- 593 and length of reproductive phase highest in JG-11. Rao and Durga (2007) [4] also observed reduction in days to 50% flowering. Similar observations were recorded by Dhiman *et al*., (2006) [1] who reported that there was delay in maturity being 20 and 10 days in *desi* and *kabuli* genotypes under irrigated condition.

Interaction between moisture stress conditions and chickpea varieties, Days to flower initiation was recorded lowest under the treatment combination S_{6L} (Water withheld from 6 leaf stage) X KAK-2 and highest under treatment combination S_0 (Non stress condition) X JG-16. The days to physiological maturity were registered highest with S_0 (Non stress condition) X IG-593 minimum values under S_{6L} (Water withheld from 6 leaf stage) X KAK-2. The length of reproductive phase was significantly higher with S_0 (Non stress condition) X JG-11 and recorded lowest with S_{6L} (Water withheld from 6 leaf stage) X JG-16. Days to 50% flowering and days to pod initiation were not influenced significantly by interaction of moisture stress condition or chickpea varieties.

Table 1: Effect of non-stress and stress conditions on phenological observations of chickpea varieties

Treatments	Phenological observations				
	Days to flower initiation	Days to 50% flowering	Days to pod initiation	Days to physiological maturity	Length of repro -ductive phase
Moisture stress conditions					
S_{6L} - Water with held from 6 leaf stage	39.48	45.70	56.19	112.52	73.04
S_{FL}- Water with Held from flowering	41.07	48.44	58.96	116.59	75.52
S_0- Non stress	42.52	50.41	61.56	118.52	76.00
SEm ±	0.21	0.21	0.27	0.09	0.29
CD (at 5%)	0.83	0.84	1.06	0.37	1.13
Chickpea varieties					
V_1-Ujjain-21	38.89	48.56	59.22	115.22	76.33
V_2- JAKI -9218	40.67	47.44	57.44	117.00	76.33
V_3- IG-593	47.22	54.11	64.00	118.78	71.56
V_4- JG-6	47.00	55.56	65.44	117.56	70.56
V_5- JG-16	48.89	55.89	65.89	116.56	67.67
V_6- JG-130	42.56	52.00	61.89	116.33	73.78
V_7- JG-412	37.78	42.56	56.00	115.44	77.67

V_8- JG-11	36.44	42.11	55.11	118.67	82.22
V_9- KAK-2	29.78	35.44	45.11	107.33	77.56
SEm ±	0.35	0.51	0.35	0.20	0.40
CD (at 5%)	1.00	1.45	1.00	0.56	1.13

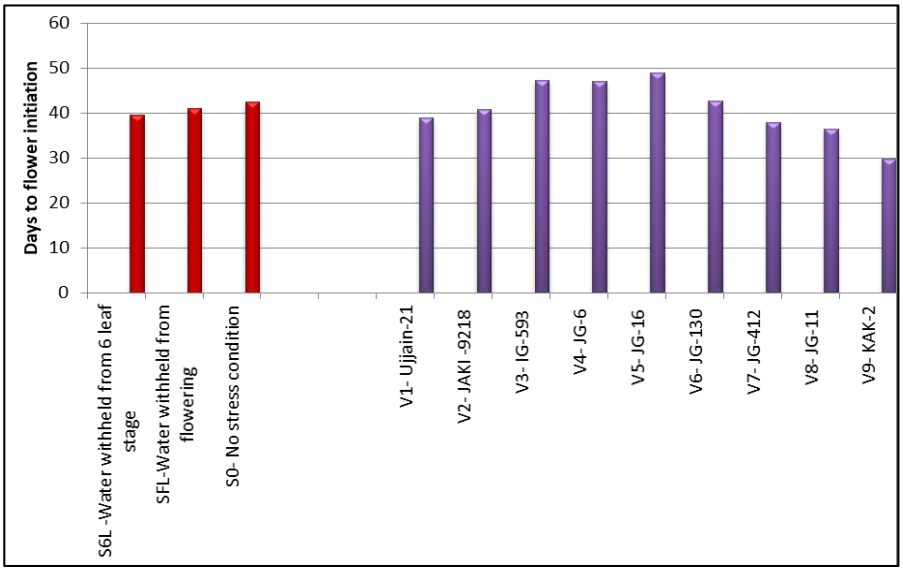

Fig 1: Effect of non-stress and stress conditions on days to flower initiation in chickpea varieties

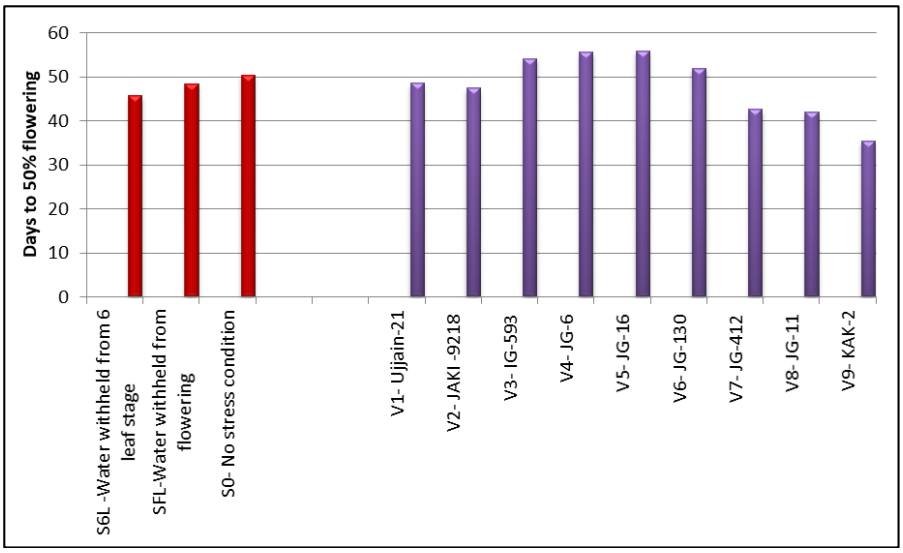

Fig 2: Effect of non-stress and stress conditions on days to 50% flowering in chickpea varieties

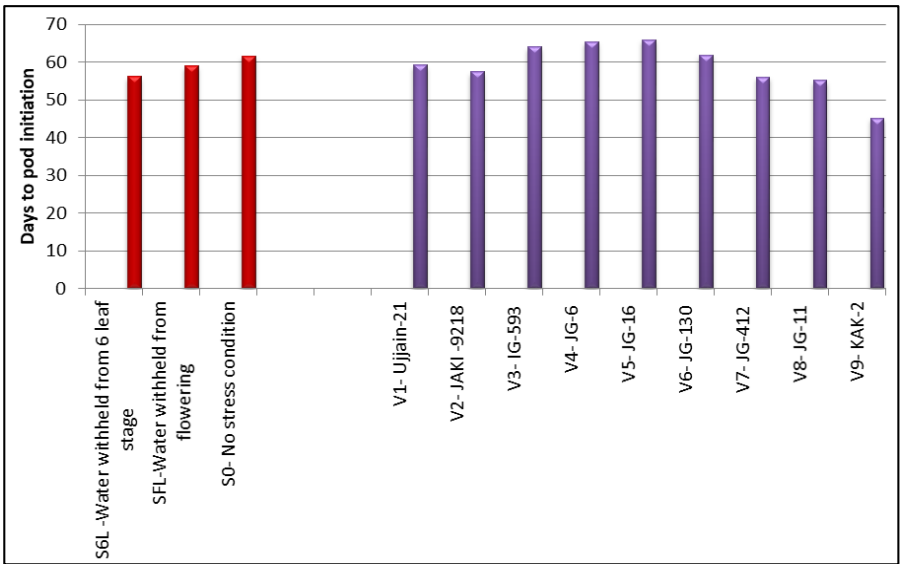

Fig 3: Effect of non-stress and stress conditions on days to pod initiation in chickpea varieties

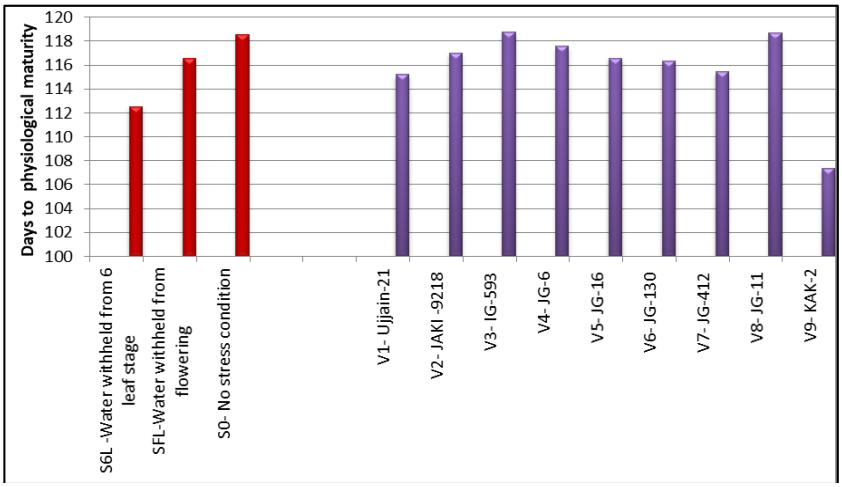

Fig 4: Effect of non-stress and stress conditions on days to physiological maturity in chickpea varieties

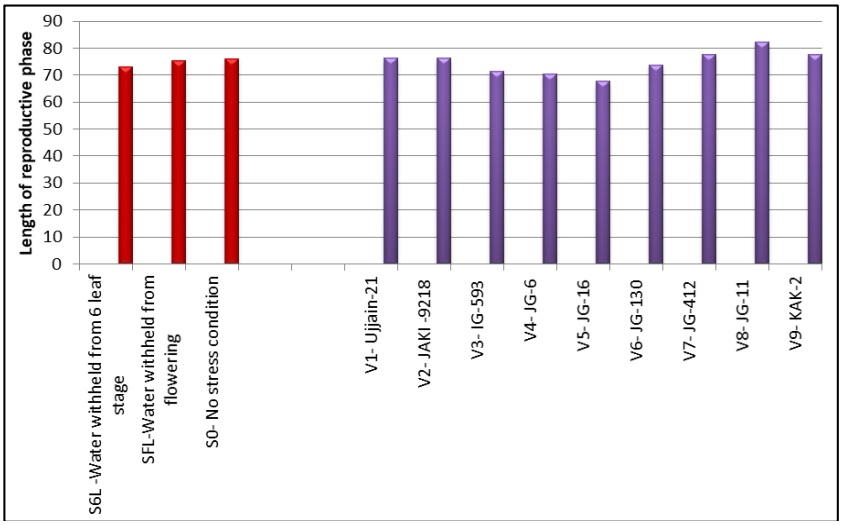

Fig 5: Effect of non-stress and stress conditions on length of reproductive phase in chickpea varieties

Conclusion

Days to flower initiation, days to 50% flowering and pod initiation was noted lowest with S_0 (Non stress condition) and with KAK- 2 under chickpea varieties. It was recorded lowest under the treatment combination S_0 (Non stress condition) X KAK-2. The days to physiological maturity were registered lowest S_{6L} (Water withheld from 6 leaf stage) and (KAK-2). It was also recorded lowest with treatment combination S_{6L} (Water withheld from 6 leaf stage) X KAK-2. The length of reproductive phase was significantly lowest with S_{6L} (Water withheld from 6 leaf stage) and with JG-16 under chickpea varieties. It was also recorded lowest with S_{6L} (Water withheld from 6 leaf stage) XJG-16 under interaction between moisture stress conditions and chickpea varieties.

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