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Seedling establishment of chickpea cultivars in varying sowing environments under field conditions

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ABSTRACT

Quantitative information about sowing time and soil temperature on seedling emergence in chickpea (*Cicer arietinum* L.) is scarce. Therefore, fifteen cultivars of chickpea were evaluated CCS Haryana Agricultural University, Hisar for cumulative seedling establishment based on per cent germination and thermo tolerance index (TI) i.e; ratio of seedlings surviving to total number of seedlings emerged during rabi seasons of 2004 and 2005 under field conditions. The TI value was constantly higher in Pusa 256 cultivar in all the experiments. The TI values ranged between 0.85 to 1.00 in Experiment 1, 0.84 to 1.00 in Experiment 2, 0.88 to 1.00 in Experiment 3, 0.84 to 1.00 in Experiment 4, 0.84 to 0.94 in Experiment 5 and 0.72 to 0.94 in Experiment 6. In general, the early sown (October) cultivars recorded higher rate of seedling emergence than the cultivars late sown (November). The results suggest that poor stand/seeding establishment of some chickpea cultivars might be due to lower initial seeding emergence rather than subsequent seedling survival and the importance of environmental conditions before emergence.

Key words: Seedling survival, chickpea, optimum environment, thermo-tolerance index, thermal requirement.

Most of the plant species respond at an optimum temperature for seed germination, above or below which seed germination is reduced (Quinlivan *et al*., 1987; Singh *et al*., 1999). Hisar has typical semi-arid climate with hot and dry summer and extremely cold winter. The mean monthly maximum and minimum temperatures show a wide range of fluctuation both during summer and winter months. Maximum temperature of around 45^0C during summer months of May to June and temperature as low as freezing point accompanied by frost in winter months of December and January occur in the region. The total rainfall as well as its distribution in the region is subjected to large variations. About 80 per cent of the annual rainfall (about 450 mm) is received during July to September. A few showers also occur during the months from December to February due to low pressure systems known as western disturbances. The rainfall is highly erratic with 20-30 per cent annual and 30-50 per cent seasonal variability. The soils of the area are grouped as Aridisols and Entisols. The soils are light textured , sandy and loamy sand.

Chickpea (*Cicer arietinum* L.) is the most important pulse crop in India. Poor seedling establishment is one of the major factors limiting the production of chickpea (*Cicer arietinum* L.) and unfavourable soil surface temperature have been reported to reduce seed germination, emergence and survival of chickpea seedling in the semi arid tropics (Gupta, 1986; Peacock *et al*., 1993; Soltani *et al*., 2006). Peacock *et al* (1990) demonstrated that high temperature (above 45^0C) around the shoot meristem of sorghum seedlings inhibited seedling growth even when moisture was not limiting. The temperature when raised to 54^0C, seedling died as a result of heat girdling of the mesocotyl, which apparently caused the blockage of phloem and so prevented the flow of carbohydrates to the roots. Results of germination studies made at constant temperature do not necessarily reflect field germination where soil temperature at seed depth fluctuates widely during the day (Singh *et al*., 1998).

MATERIAL AND METHODS

A very comprehensive evaluation of optimum germination and seedling establishment for successful adaptation programme in chickpea has been undertaken in semi-arid environment of Hisar, India. Fifteen cultivars of chickpea were evaluated on the basis of per cent germination and thermo-tolerance index (TI) i.e; ratio of seedling surviving to total number of seedling emerged. The total heat unit requirement of different chickpea cultivars up to seedling establishment was also calculated. The trials were conducted at Research Farm of CCS Haryana Agricultural University, Hisar, India (Latitude $29^0$10' N; Longitude $75^0$46' E, altitude 215.2 m a.m.s.l.) during the *rabi*/winter season of the year 2004 and 2005 and the results obtained were pooled to establish valid conclusions.

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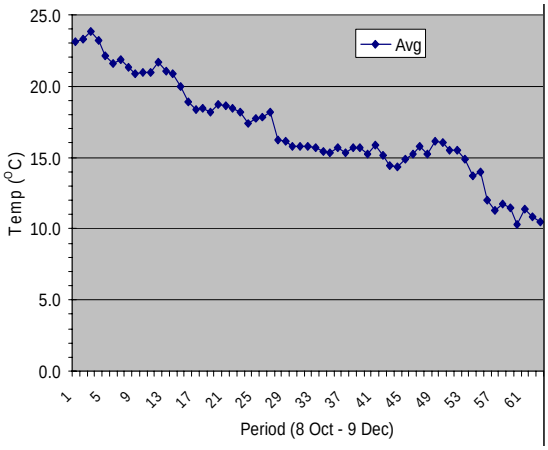

Fig. 1: Avg soil temperature during growing seasons (2004-05)

The counted seeds were sown 15 cm apart in a row of 1.5 m length with 30 cm row spacing. The rows were arranged in randomized block design with three replications and the seeds were sown on 1st October (Expt. 1), on 10 October (Expt. 2), on 20 October (Expt. 3), on 1 November (Expt. 4), on 10 November (Expt. 5) and on 20 November (Expt. 6) during both the years under adequate moisture availability. Soil temperature of sub-surface (5 cm depth) was measured daily tili the end of the experiments. The air temperature recorded in adjacent agro-meteorological observatory was taken for thermal requirement calculations. Recording of seedling emergence commenced immediately after the first seedling was seen and continued until no further emergence.

RESULTS AND DISCUSSION

The numbers of live seedlings were counted daily and dead seedlings were marked to provide the check against loss of seedlings by any other means. The average soil temperature up to seedling root depth ranged between 20.9^0 to 23.2^{0}C in Expt 1, 18.2 to 21.0 ^{0}C in Expt. 2, 15.8 to 18.6 ^{0}C in Expt. 3, 14.4 to 15.8^{0}C in Expt. 4, 12.0 to 16.2^{0}C in Expt. 5 and 10.3 to 15.5^{0}C in Expt. 6 (Fig. 1) during the reference period. Overall, the soil temperature in the root zone showed decreasing trend with the commencement of growing season (October to November) of chickpea and it ranged between 10.3^{0}C (Expt 6) to 23.2^{0}C (Expt. 1). Considerable variation in emergence among genotypes and sowing environment was noticed (Table 1). During the October sowings, the germination percentage was higher than the November sowings in most of the cultivars. In October sown experiments, less than 90 per cent germination was reported in cultivars HK-1, HC-5 (Expt. 1), HK-1, H-208, Gora Hisari (Expt. 2) and the germination percentage was below 90 per cent in all the cultivars sown in experiment 3. For November sowings, the germination percentage recorded ranged between 80 to 95 per cent (Expt. 4 and 5) and 70 to 95 per cent in experiment 6. Such variation may be largely due to genetic character of the cultivar/genotype and different thermal environments under which study was undertaken. Among various experiments, cultivars with different varietal characters (early, timely and late sown varieties) exhibited different germination performance depending upon the field and its ambient regimes.

In general, the thermo-tolerance index (TI) was reported to be higher in October sown experiments than in the November sown experiment (Table 1) in most of the cultivars with few exceptions. The range of thermo-tolerance index was observed between 0.85 to 1.00 in October sown experiments and 0.72 to 0.94 in November sown experiments indicating higher rate of establishment of seedlings in early sown cultivars when compared with late sown cultivars. Among October sown cultivars low TI (<0.90) was observed in ICCV-9001, ICCV-9516 and ICCV-3127 (0.88), H-208 (0.85), ICCV-3127 and H Guarav (0.89), CSG- 8962 (0.84) showing varietal character variation to establish with in the short span of seeding under field conditions. In November sown cultivars, the TI was comparatively low than the October sowing and the low TI (<0.85) was observed in ICCV-9001 and C-235 (0.84), PDG 84-16 (0.83), C-235 (0.82), H Gaurav (0.78), CSG 8962 (0.75) and Gora Hisar (0.72). Such variations in emergence among cultivars was also reported by Mohammad (1984) and Singh *et al* (1999). Temporal variations in emergence and establishment may be attributed to varietal character difference, However, the low emergence and establishment in November sown cultivars may be attributed to unfavorable ambient temperature.

In October sowings, cultivars needed below 330 day ^{o}C accumulated heat units (234.8 to 329.8 day^{o}C) for their

Table 1 : Seedling emergence (%) and thermo-tolerance index (TI) of chickpea cultivars

Cultivars	Seed emergence (%)				
	D1	D2	D3	D4	D5
HC-3	100	100	80	80	95
Pusa 256	95	100	75	90	85
HK-1	85	85	85	95	90
CSG 8962	100	100	80	80	95
HC-1	100	100	85	90	90
HC-5	85	90	85	90	80
PDG 84-16	95	95	80	85	85
ICCV-9001	95	90	70	80	85
ICCV-9516	90	90	80	90	90
C-235	100	95	85	90	85
ICCV-96029	100	100	80	80	95
H 208	90	85	80	90	80
ICCV-3127	95	90	85	85	90
Gora Hisari	95	85	75	95	90
H Gaurav	100	100	85	90	100

D1-Expt. 1, D2-Expt. 2, D3-Expt. 3, D4-Expt. 4, D5-Expt. 5, D6-Expt. 6

Table 2 : Thermal requirement (day ^{0}C) of different chickpea for seedling establishment

Cultivars	Thermal requirement (day ^{0}C)					
	D1	D2	D3	D4	D5	D6
HC-3	329.8	279.5	278.7	291.1	317.1	349.5
Pusa-256	329.8	279.5	278.7	291.1	317.1	349.5
HK-1	302.8	290.6	248.9	302.6	326.2	307.8
CSG-8962	316.7	290.6	262.7	291.1	317.1	335.9
HC-1	316.7	290.6	262.7	291.1	326.2	335.9
HC-5	316.7	301.4	248.9	291.1	326.2	335.9
PDG 84-16	283.9	301.4	234.8	276.9	336.3	307.8
ICCV-9001	316.7	290.6	262.7	276.9	336.3	335.9
ICCV-9516	316.7	290.6	262.7	291.1	326.2	335.9
C-235	316.7	290.6	248.9	276.9	336.3	335.9
ICCV-96029	302.8	301.4	248.9	314.2	326.2	293.7
H-208	316.7	301.4	262.7	291.1	317.1	335.9
ICCV-3127	302.8	290.6	262.7	291.1	317.1	321.8
Gora Hisari	302.8	301.4	234.8	263.0	326.2	335.9
H Gaurav	329.8	290.6	248.9	276.9	336.3	335.9

establishment (Table 2). However, the cultivars sown during November month required higher range of heat units (263.0 to 349.5 day °C) to attain their establishment. Gora Hisari cultivar performed well in both the months requiring 234.8 day°C in October and 263.0 day°C in November month. The variation may be attributed to higher ambient temperature as well as soil temperature (18.0 to 25.0°C) in October compared to relatively low soil temperature (10.0 to 18.0°C) in November month at 5 cm depth. It may be concluded here that soil temperature had a strong influence on the germination and seedling establishment of different chickpea cultivars. Therefore, recommendation can be made for sowing of a cultivar at a particular location by using prevailing temperature conditions.

The results suggest that poor stand/seedling establishment of some chickpea cultivars might be due to lower initial seedling emergence rather than subsequent seedling survival, thereby establishing the importance of environmental conditions before emergence. The study suggests that variations in emergence between cultivars could be reduced if all seeds were produced under similar conditions. Cultivars requiring fewer amount of growing degree days are most acceptable in the cropping system of this region.

It is pertinent to continue to combine the data obtained on final emergence with that for thermo-tolerance index to prepare survival index as a guide to environment adoption to fit in cropping systems of this region.

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