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Effect on seed vigour and soil-moisture content of spring sunflower (*Helianthus annuus*) hybrid and yield influenced by sowing time and irrigation

OM SINGH[1] AND P.C. GUPTA[2]

Department of Agronomy, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal 263 124

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ABSTRACT

An experiment was conducted during 1998 and 1999 at Pantnagar, to study effect of sowing time and irrigation on seed vigour and soil moisture and yield of sunflower (*Helianthus annuus* L.). Date of sowing and irrigation significantly influenced phenology, available soil moisture, seed-moisture contents and seed vigour. However, irrigation did not affect germination (%) and shoot length significantly. Seed-moisture content could also not affect by date of sowing significantly. Dormancy effect just after harvest and storability effect after 4 months were also observed.

Key words : Seed vigour, Yield, Soil moisture, Sowing date, Irrigation

The development of short-duration, photo- and thermo-insensitive high-yielding varieties having wider adoptability has revolutionized the cultivation of sunflower (*Helianthus annuus* L.) in different agro-climatic regions of India. Conventionally, this crop is grown in the southern states in different seasons either as rainfed or irrigated under varying soil types and cropping systems. In the north western India, the cultivation of sunflower picked up during the nineties and has now become an important cash crop in the spring season (January/February–May) under irrigated condition. High yield can be obtained from sunflower provided proper irrigation scheduling based on physiological stage criterion is adopted.

Temperature and moisture may also affect the seed yield and quality. Germination or seed vigour is directly related to seed quality. Soil-moisture depletion is to be observed for quantification of irrigation. Hence the present experiment was conducted to find out optimum sowing time and irrigation scheduling for good-quality seeds of sunflower.

Present address : [1]Division of Extension Education, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh 243 122

MATERIALS AND METHODS

A field experiment was conducted at Crops Research Centre, Pantnagar, (79°3'E and 29°N at an altitude of 245.83 m above the sea-level). Pantnagar has hot and dry summer, cold winter and heavy rains during monsoon. The soil was sandy loam (Mollisols), growing period of 150–180 days with soil pH 7.2, bulk density 1.58 g/cm^3, field capacity 17% and permanent wilting point 10.4%. The experiment was conducted in split-plot design with 4 replications, as dates of sowing in main plots and irrigation in subplots. The treatments comprised 3 dates of sowing, viz. 5 February (D_1), 20 February (D_2) and 7 March (D_3), and 4 levels of irrigation, viz. irrigation at all growth stages (I_1), 1 missed irrigation at pre-flowering (I_2) or flowering (I_3) or grain filling (I_4). The crop was sown in 3:1 ratio of parental lines ('234 A' and '35 R') with 20 cm × 60 cm planting distance having 8 kg seed/ha. Crop was raised with recommended practices.

Soil samples before irrigation of the crop were collected from each plot up to 0–30 cm soil depth. The moisture content was calculated on oven-dry weight basis by using thermo-gravimetric method. Seed-moisture content at harvest was determined by Universal OSAW moisture meter. Germinations were counted at day 4 and 10 in germinator. During growing seasons mean minimum of 4.6 to 26.3°C and maximum of 19.6 to 39.8°C temperature were recorded. Relative humidity varied from 32.5 to 73.7%. The rainfall received during crop-growing period was 149.0 and 172.6 mm in 1998 and 1999, respectively.

RESULTS AND DISCUSSION

Available soil moisture

The moisture (%) based on dry weight of soil up to 0–30 cm depth was significantly influenced by date of sowing at preflowering in both the years and at harvest only in 1999. However, flowering and grain-filling stages did not show any significant effect. The moisture content at field capacity and permanent wilting point was 17% and 10.4% respectively. The available soil moisture, was calculated for different stages. At pre-flowering maximum available soil moisture over PWP was 3.5% in 1998 and 2.7% in 1999 when planting was done on 5 February, i.e. maximum soil-moisture content 13.9% and 13.1% in respective years at pre-flowering before irrigation. However, minimum soil-moisture content and available soil moisture were recorded, when planting was done on 7 March. But, at harvest maximum 1.5% (soil moisture content 11.9%) and minimum–0.3% (soil moisture content 10.1%) available soil moisture was recorded in second and third dates of planting during 1999.

Maximum available soil moisture at pre-flowering in 5 February sown crops might be due to lower evapo-transpiration rate because of lower temperature in February than the 7 March sown crop. The crop sown on 7 March also had faster growth rate up to pre-flowering. In 1999 same trend was also found at harvest stage. Yadav (1972) at Pantnagar found that time taken for flowering was 64 days in March and 51 days in July sowings, which indicates pace of growth and development

of crop as influenced by daily temperature. Fluctuation of 2°C daily mean temperature in the range of 16.5°C to 28.3° resulted in ± 2 days difference in the period of emergence to heading (Chen *et al.*, 1987).

Scheduling of irrigation had significant influence on available soil moisture except at pre-flowering in 1998 and flowering in both years. At pre-flowering, maximum available soil moisture 2.9% (soil moisture content 13.6%) in 1999 was recorded in I_1 treatment. However, minimum available soil moisture 1.7% (soil moisture content 12.1%) was recorded in I_4 treatment in this year. At flowering maximum available soil moisture 2.9% (soil moisture content 13.6%) was observed in I_1 treatment during 1998 and minimum 2% (soil moisture content 10.4%) with I_2 treatment in 1998. Moreover, these values were non-significant. Maximum available soil moisture 1.5% (soil moisture content 11.9%) and 2.3% (soil moisture content 12.7%) at grain filling with I_1 treatment and minimum available soil moisture 2.1% (soil-moisture content 11.5%) and –0.1% (soil-moisture content 10.3%) was recorded during respective years, which were significantly different. Similarly, at harvest maximum available soil moisture was found higher with I_1 and I_2 treatments. whereas minimum (–1.3% and –0.1%) was recorded in I_4 treatment in 1998 and 1999 respectively.

Maximum available soil moisture with I_1 treatment was recorded at all growth stages due to no missing irrigation. One missed irrigation at pre-flowering (I_2) or at flowering (I_3) or at grain filling (I_4) had significant stress effect at next irrigation

Table 1. Effect of dates of sowing and irrigation levels on soil-moisture content (%) before irrigation at different crop-growth stages and seed yield

Treatment	Pre-flowering		Flowering		Grain filling		Harvesting		Sed yield (q/ha)	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Date of sowing										
5 February (D_1)	13.9	13.1	12.5	11.4	12.2	12.3	11.1	11.4	21.2	21.3
20 February (D_2)	13.1	12.6	12.0	12.6	11.1	11.9	10.7	11.9	22.8	22.6
7 March (D_3)	12.6	12.5	11.8	11.8	10.9	11.9	10.2	10.1	19.0	19.1
CD (P=0.05)	0.6	0.3	NS	NS	NS	NS	NS	NS	0.5	0.7
Irrigation scheduling										
Irrigation at all growth stages (I_1)	13.6	13.6	13.6	12.0	11.9	12.7	11.4	11.9	22.8	23.5
1 irrigation missed at pre-flowering (I_2)	13.3	12.4	10.4	11.9	11.8	12.4	11.8	11.7	21.0	20.7
1 irrigation missed at flowering (I_3)	12.9	12.9	12.9	12.3	11.6	10.6	11.4	10.6	19.9	20.0
1 irrigation missed at grain filling (I_4)	13.0	12.1	12.6	11.5	11.5	10.3	9.1	10.3	19.9	20.0
CD (P=0.05)	NS	0.8	NS	NS	0.7	0.8	0.8	0.5	0.5	0.9

Table 2. Effect of dates of sowing and irrigation levels on seed vigour, germination of sunflower at different intervals of strorability

Treatment	Laboratory tests for seed vigour													
	Seed moisture content (%) at harvest		At harvest				After 2 months				After 4 months			
			Germination (%)		Shoot length (cm)		Germination (%)		Shoot length (cm)		Germination (%)		Shoot length (cm)	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Date of sowing														
5 February (D_1)	11.8	12.0	64.2	76.1	6.2	5.7	89.6	87.7	19.0	17.1	71.4	72.1	15.6	14.6
20 February (D_2)	11.4	12.2	55.5	73.1	4.6	4.6	86.2	86.7	17.6	16.6	75.1	74.3	17.1	16.1
7 March (D_3)	11.1	11.5	51.7	57.7	4.2	3.3	85.7	85.3	16.4	15.9	84.5	82.8	16.8	16.8
CD (P=0.05)	NS	NS	9.3	6.9	1.2	0.3	NS	NS	1.6	NS	NS	5.6	NS	NS
Irrigation scheduling														
Irrigation at all growth stages (I_1)	13.1	12.9	54.0	68.2	5.0	5.4	86.4	85.5	16.8	15.7	74.7	76.0	16.4	16.2
1 irrigation missed at pre-flowering (I_2)	10.9	12.0	57.9	69.3	5.5	4.4	86.0	85.4	17.0	16.5	78.5	77.5	17.5	16.5
1 irrigation missed at flowering (I_3)	11.4	11.9	55.4	72.0	5.0	4.0	89.1	88.4	19.0	17.5	79.0	77.6	17.2	16.2
1 irrigation missed at grain filling (I_4)	10.3	10.9	61.3	66.5	4.6	4.3	87.2	87.0	17.7	16.5	75.8	74.8	14.9	14.5
CD (P=0.05)	1.1	0.8	NS	NS	NS	1.0	NS	NS	NS	NS	NS	NS	NS	NS

stage, i.e. at flowering, grain filling and harvesting, because 1 missed irrigation showed stress effect after a few days as compared to other treatment where no irrigation was missed. This effect may influence the phenology of the crop.

Soriano *et al.* (1994) observed that sunflower seed yield was most sensitive to water stress after anthesis. The sunflower irrigation management under limited water supply should be concentrated on reproductive period. In a field experiment conducted in western Uttar Pradesh it was found that more frequent irrigation delayed the physiological stages of the crop (Tomar *et al.*, 1995).

Seed yield

The maximum seed was recorded when crop was sown on 20 February and minimum when sunflower was planted on 7 March. This reduction was 16.6% in 1998 and 15.4% during 1999. The seed yield value of crop planted on 5 February was significantly higher than 7 March planted crop and lower than 20 February sown crop. The seed yield was also significantly influenced by irrigation levels. The maximum seed yield was recorded in the treatment where irrigation was applied at all critical growth stages in both the years. The minimum seed yield was recorded when the irrigation was missed at 50% flowering or at 50% grain filling, being 12.7% less seed yield in 1998 and 14.8% during 1999 compared to the crop irrigated at all growth stages. Among irrigation treatments I_2, I_3 and I_4 where 1 irrigation was missed at different stages, viz. at pre-flowering, flowering and grain-filling. The lowest adverse affect on seed yield reduction (7.8% in 1998 and 11.9% during 1999) was observed in I_2 treatment. where 1 irrigation was missed at pre-flowering than I_3 and I_4 treatments. This is might be due to that I_2 treatment applied before reproductive stage could recover stress effect up to flowering while I_3 and I_4 could not.

Seed-moisture content

Seed-moisture content (%) at just after harvest or threshing time was recorded. Moisture content decreased as date of sowing was advanced. However, this difference was non-significant. This difference might be due to increase in temperature at harvest. Effect of irrigation scheduling was also significant. Seed-moisture content decreased from I_1 to I_4 significantly might be because of stress created at grain-filling by 1 missed irrigation could not translocate water supply to the seed. Higher temperature in April-May also contributed to reduction in seed moisture (%).

Effect on seed vigour

Effect of sowing time and irrigation on germination (%) and shoot length at 2 months regular intervals was recorded. First time, this effect was recorded just after threshing of seeds which were kept for germination tests in incubator. Maximum germination (%) and shoot length was recorded in first sowing and decreased significantly in 7 March sown crop. This difference was perhaps due to variation in days taken to harvest. Crop harvested early produced more germinated seeds. In next observation after 2 months storage was

recorded, there was sharp increase in germination (%) and shoot length. However, the trend was same as at the previous time, i.e. values decreased as sowing date was advanced. This sharp increase in values was due to break-up in dormancy after a few months, hence more seed could not be able to germinate after thrashing. Similar trend in shoot or root length was also recorded might be due to that first harvest could get more time to break up in dormancy and release of nutrients for quick growth of shoots. At last after 4 months of storage of seeds and effect of similar factors was found to be reversed. Germination (%) and shoot length were increased significantly with advancement in date of sowing. This reversal effect was might be due to storage effect. First date harvested seeds kept for storage for longer time than the third-date sown crop. Hence this deterioration effect was higher in 5 February sown crop at laboratory tests after 4 months of storage of seeds.

Irrigation scheduling did not affect germination (%) and shoot growth significantly. However, bolder seeds maintained their seed vigour also. Seed produced under moisture-stress condition slightly added to loss in seed viability. Optimum soil moisture of pre-sowing irrigation enhanced germination (%). It is found that water stress caused large reduction in seed yield, biomass and period of vegetative growth (Mozaffari *et al.*, 1996).

REFERENCES

Mozaffari, K., Arshi and Zeinal, K.H. 1996. Research on the effects of water stress on some morphological traits and yield components of sunflower. *Seed and Plant* 12(3) : 24–33.

Yadav, R.L. 1972. 'Influence of monthly chain planting on growth, development and yield behaviour of sunflower.' M.Sc. Thesis, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh.

Chen, J.Z., Sun, S.Y. and Zhang, Y.L. 1987. A study of sowing date of oil sunflower. *Oil Crops of China* 1 : 48–51.

Soriano, M.A., Villalobos, F.J., Fereres, E., Ingaz, F., Borin, M. and Sattin, M. (eds) 1994. Response of sunflower grain yield to water stress applied during different phenological stages. (In) : *Proceedings of the third Congress of the European Society of Agronomy, Podoya, University of Abano, Podava, Italy.*

Tomer, H.P.S. Dadhwal, K.S. and Singh, H.B. 1995. Effect of irrigation, nitrogen and phosphorus on physiological stage of spring sunflower. *Indian Journal of Soil Conservation* 23(1) : 84–85.