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Suresh Mhaske
Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

KK Agrawal
Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Manish Bhan
Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Correspondence
Suresh Mhaske
Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Growth, yield and economics of chickpea types as influenced by different thermal environment and irrigation

Suresh Mhaske, KK Agrawal and Manish Bhan

Abstract
A field experiment was conducted to study the responses of chickpea types on growth, yield and economics under different thermal environment and irrigation levels during *rabi* seasons of 2017-18 and 2018-19 at Research Farm, Department of Physics and Agrometeorology Jawaharlal Neharu Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh). The experiment was laid out in split split-plot design with three replications consisted of three sowing dates *viz*., November 15th, December 1st and December 15th, three chickpea types *viz*., JG 14 (Deshi), JGG 1 (Gulabi) and JGK 1 (Kabuli) with three irrigation levels (No irrigation, Irrigation at 50% branching and two irrigation each at 50% branching and pod development) as main plot, sub-plot treatments and sub sub-plot, respectively. Results revealed that Plant height, number of branches, number of filled pods, 100 seed weight, seed yield, Stover yield and harvest index decreased with successive delay in sowing. December 1st sowing produced significantly higher plant height, number of branches, number of filled pods, 100 seed weight, Seed yield (2090.08 kg ha^{-1}), Stover yield (2832.85 Kg ha^{-1}), harvest index (45.55%), net income (Rs 61247.80 ha^{-1}) and B:C ratio (2.50) as compared to November 15th and December 15th. Among cultivars, seed yield (1959 Kg ha^{-1}) and harvest index (43.54%), Net monitory return (Rs 54948.22 ha^{-1}) and B:C ratio (2.35) were found maximum in JG 14 (*Deshi*) chickpea type. Irrigation each at 50% branching and pod development stages is produced maximum seed yield (2034.81 kg ha^{-1}), Stover yield (2733.84 Kg ha^{-1}),harvest index (42.60%),net income (Rs 57965.76 ha^{-1}) and B:C ratio (2.39) over no irrigation and one irrigation at 50% branching.

Keywords: Chickpea types, irrigation, growth, yield, economics

Introduction
Chickpea (*Cicer arietinum* L.) is most important pulse crop of *rabi* season cultivated mainly in semi arid and warm temperature regions of the world. India is the largest producer of chickpea i.e. 65% of world chickpea production. Chickpea is the third most important food legume crop is grown under diverse range of aerial environments hence; different genotypes are needed that are well adapted to the vagaries of weather and climate at different places. The crop needs cool weather conditions during early parts of its growth. In India during 2017-18 chickpea was cultivated in an area about 10.56 million hectare with a production about 11.23 million tones with productivity of 1063 kg/ha (Anonymous 2018) [1]. Madhya Pradesh ranks first among all state in both area and production of chickpea. In Madhya Pradesh it was cultivated in an area of about 3.59 million hectare with production 4.59 million tones with productivity of 1082 kg/ha (Anonymous 2018) [1].
Even though, India ranks first in acreage and production of chickpea in the world. Chickpea faces various abiotic stresses during its life cycle such as drought, cold, thermal heat and salinity (Ryan, 1997, Millan *et al*., 2006) [7, 5]. The yield looses due to abiotic stresses may exceed those caused by biotic stresses (Ryan, 1997) [7]. Drought stress and high temperature during the spring season especially at the time of pollination or among the environmental parameters adversely influenced chickpea growth and yield (Krishnamurthy *et al.,* 2011) [4]. By selecting suitable planting times it is likely to avoid the adverse effects of high temperatures on cool adapted legumes (Upadhyaya *et al*., 2012) [10].
Optimum sowing time and selection of improved chickpea types play a remarkable role in exploiting the yield potential of the crop under particular agro climatic conditions. Sowing dates and irrigation has been proved to affecting the yield of chickpea. The optimum sowing time and irrigation is important to exploit the environmental conditions during the growth of chickpea for maximum production.

Delay in sowing causes early maturity resulting drastic reduction in yield. Keeping view in mind, the present experiment had been conducted to find out optimum sowing window and irrigation levels for different chickpea types.

Materials and Methods

The field experiment was conducted at Research Farm, Department of Physics and Agrometeorology, J.N.K.V.V., Jabalpur (23° 09' N latitude, 79° 59' E longitude at an altitude of 411 m above mean sea level), Madhya Pradesh, India during two consecutive *rabi* seasons of 2017-18 and 2018-19. The soil of the experimental site was sandy clay loam with pH 7.5, EC 1.48 ds/m and organic carbon 0.68%. The total annual rainfall is 1350 mm. The experiment was laid out in split split-plot design with three replications consisted three sowing dates *viz*., November 15th, December 1st and December 15th, three chickpea types *viz*., JG 14 (Deshi), JGG 1 (Gulabi) and JGK 1 (Kabuli) with three irrigation levels (No irrigation, Irrigation at 50% branching and two irrigation each at 50% branching and pod development) as main plot, sub-plot treatments and sub sub-plot, respectively. The rainfall during the crop season was 19.4 and 51.8 mm, which was received in 3 and 5 rainy days during 2017-18 and 2018-19. The crop was grown with all recommended package of practices of the region and application of irrigation was followed as per the treatments. Immediately after crop establishment, five plants were randomly selected from each plot for recording periodical observations on yield attributing parameters like Plant height, number of branches, number of filled pods, 100 seed weight, seed yield, biological yield and harvest index. Net monitory returns and B:C ratio were also worked out to asses the economic viability of treatments. The data collected were statistically analysis as per method of "Analysis of variance Technique" appropriate for Split-split plot design for interpretation of results given by Steel and Torrie, 1960.

Results and Discussion

Effect of date of sowing

Results of analysis of mean data indicated that yield, yield attributes and economics of chickpea types differ significantly under crop grown at different dates. The plant height (45.66 cm), Number of branches plant^{-1}(16.28), Number of filled pods plant^{-1}(31.51), 100 seed weight (20.87 g), were recorded higher when crop sown on 1st December over rest of the sowing dates. Seed yield (2090.08 kg ha^{-1}), Stover yield (2832.85 Kg ha^{-1}), harvest index (45.55%), net income (Rs 61247.80 ha^{-1}) and B:C ratio (2.50) were also maximum over rest of the sowing treatment (Table1).Similar results were also reported by Agrawal *et al*., 2002.

Table 1: Effect of sowing dates and irrigation levels on growth, yield and economics of different chickpea types

Treatments	Plant height (cm)	No. of Branches (plant^{-1})	No. of Filled pod (plant^{-1})	100 seed weight (g)	Seed yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})	Harvest Index (%)	Net return (Rs ha^{-1})	B:C ratio
Sowing Dates									
E_1 - 15th Nov.	44.40	15.70	30.38	20.45	1976.83	2661.63	44.75	55271.82	2.36
E_2 - 1st Dec.	45.66	16.28	31.51	20.87	2090.08	2832.85	45.55	61274.80	2.50
E_3 - 15th Dec.	38.49	14.58	27.46	20.43	1616.99	2484.14	37.51	39760.51	1.97
SE m ±	0.49	0.05	0.54	0.10	7.43	6.88	0.11	-	-
CD (P = 0.05)	1.94	0.22	2.12	0.32	29.04	26.87	0.43	-	-
Irrigation levels									
I_0 - No irrigation	35.88	13.97	25.66	20.53	1760.28	2583.50	40.51	46782.10	2.17
I_1 - One irrigation	44.65	16.25	29.82	20.45	1879.80	2661.22	41.27	51559.26	2.27
I_2 - Two irrigation	48.03	16.35	33.89	20.77	2034.81	2733.84	42.60	57965.76	2.39
SE m ±	0.52	0.15	0.48	0.07	10.18	6.62	0.15	-	-
CD (P = 0.05)	1.68	0.46	1.47	0.24	31.38	20.61	0.47	-	-
Chickpea types									
V_1 - *Deshi* JG 14	45.94	15.13	29.66	23.93	1959.23	2698.99	43.54	54948.22	2.35
V_2 - *Gulabi* JGG 1	37.53	17.27	35.71	14.11	1838.59	2758.62	40.57	49730.85	2.22
V_3 - Kabuli JGK 1	45.09	14.16	23.99	23.70	1877.07	2521.01	40.27	51628.06	2.26
SE m ±	0.27	0.15	0.38	0.05	6.95	5.00	0.12	-	-
CD (P = 0.05)	0.78	0.43	1.11	0.18	19.94	14.36	0.37	-	-

Effect of irrigation levels

Irrigation at every critical and sensitive stage is directly affected the crop yield and productivity. Irrigation each at 50% branching and pod development stages is produced maximum yield, yield attribute and income. The plant height (48.03 cm), Number of branches plant^{-1} (16.35), Number of filled pods plant^{-1} (33.89), 100 seed weight (20.77 g), were recorded higher with two irrigation levels over rest of the irrigation treatments. Seed yield (2034.81 kg ha^{-1}), Stover yield (2733.84 Kg ha^{-1}), harvest index (42.60%), net income (Rs 57965.76 ha^{-1}) and B:C ratio (2.39) were also maximum over no irrigation and one irrigation at 50% branching (Table1) Thorat *et al*., 2016 [9] and Jain *et al*., 2018 [6] reported the same results.

Effect of Chickpea types

All the yield attributing characters like number of branches, number of pods, test weight and harvest index were significantly varied due to different chickpea types (Table 1).While comparing the different chickpea types, the plant height (45.94 cm) and 100 seed weight (23.93 g), were recorded higher in JG 14 (*Deshi*) type, Whereas number of branches plant^{-1} (17.27), Number of filled pods plant^{-1} (35.71) and Stover yield (2758.62 Kg ha^{-1}) were recorded more in JGG 1 (*Gulabi*) type, but JGG 1 (*Gulabi*) type recorded leaser 100 seed weight (14.11 g) that's why the seed yield (1959 Kg ha^{-1}) were found maximum in JG 14 (*Deshi*) chickpea type. The harvest index (43.54%), Net monitory return (Rs 54948.22 ha^{-1}) and B:C ratio (2.35) were found higher in JG

14 (*Deshi*) type over JGG 1 (*Gulabi*) and JGK 1 (Kabuli) types. The findings of Agrawal *et al*., 2010, Silawat *et al*., 2015, Agrawal and Upadhyay, 2009 [3] are closely related to this.

Conclusion

On the basis of present study it could be concluded that sowing of *Deshi* chickpea type on December 1st with two irrigation level exhibited significantly higher growth and yield due to optimal conditions for growth and development of chickpea crop. The yield of chickpea types decreased with delay in sowing beyond December 1st.

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