

Original Research Article

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Response of Varieties and Sowing Dates on Water Productivity of Chickpea in Kymore Plateau and Satpura Hills Agro-climatic Zone of M.P.

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ABSTRACT

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To study on water productivity of chickpea under different combinations of varieties and sowing dates. A study was carried out during Rabi 2019-20 in the research farm of Jawaharlal Nehru Krishi Vishwavidyalaya Jabalpur. Three chickpea varieties (JG-14, JGG-1, JGK-1) and three dates of sowing (15th Nov, 30th Nov, 15th Dec) were considered for the study. The statistical analysis was carried out in split plot design. The maximum water productivity of chickpea variety JG-14 ($97 \text{ kgha}^{-1}\text{cm}^{-1}$) was significantly superior to variety JGK-1 and JGG-1. The water productivity of chickpea variety JGG-1 ($88 \text{ kgha}^{-1}\text{cm}^{-1}$) and variety JGK-1 ($89 \text{ kgha}^{-1}\text{cm}^{-1}$) both were at par. The water productivity of sowing dates 15th Nov ($97 \text{ kgha}^{-1}\text{cm}^{-1}$) and 30th Nov ($93 \text{ kg ha}^{-1}\text{cm}^{-1}$) were at par but significantly superior to sowing date of 15th Dec ($84 \text{ kgha}^{-1}\text{cm}^{-1}$).

Introduction

Chickpea (*Cicer arietinum L.*) is cultivated almost in all parts of the country mainly as a rainfed crop (68%) area by (ICRISAT, 2003). Chickpea is a very important pulse crop in the leguminous family. This light brown coloured pulse is considered to be a good source of protein and is also called by the name of “Garbanzo beans”. It is used as an edible seed and is also used for making flour throughout the world. During 2017-18 chickpea

production has been estimated to be about 11.23 million tonnes at a record productivity level of 1063 kg/ha in an area of 10.56 Million ha. Madhya Pradesh is the major production state which contributes 8Mt which is maximum in any state. The area, production and productivity of chickpea in Madhya Pradesh is 2.90 million ha, 3.50 Million Tonnes and 1219 kg/ha. Irrigation consumes more water than any other activity, and thus the challenges of water sustainability and food security are closely linked. Water

scarcity is the lack of sufficient available water resources to meet water needs with in a region. Water scarcity involves water shortage, water stress or deficits, and water crisis. It may result in further depletion and deterioration of available water resources. The main objective of chickpea is to get maximum production in minimum amount of water use.

Patel *et al.*, (2014) water productivity to improve chickpea production in Bansagar Command Area of Madhya Pradesh, four water management treatments consisting two farmers practices i.e., two irrigation by flooding method and two improved practices i.e., two irrigation at flowering and pod formation stage with border strip method. Water productivity was found better in improved practice (98.2 kg/ha/cm) as compared to farmers practices. Silva *et al.*(2014) evaluated the improvement on chickpea crop yield and water productivity. The results show that all chickpea varieties responded to supplemental irrigation with the increase in grain biomass yield. Ranjan and Sahu (2016) analysed the water productivity of *Dalbergia sissoo* L. Paddy based agroforestry system in response to pruning, nitrogen application and varied seed rate. The paddy equivalent water productivity of agroforestry (141 kg ha⁻¹cm⁻¹) and silviculture (159 kg ha⁻¹cm⁻¹) was at par but much higher than the agricultural (37kg ha⁻¹cm⁻¹) practice. Kumar and Sahu (2018) described the Dynamics of Water Productivity under Agriculture and Agroforestry Land Use System in Jabalpur, M.P. The water productivity of agroforestry was (321 kg ha⁻¹cm⁻¹) while in agriculture it was (90kg ha⁻¹cm⁻¹). Singh *et al.*, (2019) observed the study was carried out by KVK, Sidhi M.P. The highest yield was recorded in the FLDs was (10.20 q/ha) and in case of farmers practice (7.80 q/ha). Tripathi *et al.*, (2019) explained the different application methods

i.e. (sprinkler irrigation system, border irrigation and flood irrigation) and different sowing methods were applied in wheat crop. These practices may reduce on farm irrigation water application and crop yields.

Materials and Methods

The details of material used and the methods adopted during in search of the best variety and sowing dates which gives higher water productivity the current study was under taken in Jabalpur, Madhya Pradesh, India.

Study area

The field experiment was carried out at research farm of College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (M.P.) in rabi (2019-20).

Location and extent

Study area lies between 23⁰21'00''N latitudes and 79⁰96'00''East longitude. Study area belongs to Kymore Plateau and Satpura Hills Agro-climatic Zone as per classification of National Agricultural Research Project. Recently this area has been classified as agro-ecological sub-region number 10.1 (Vindhyan Scarp lands, Bundelkhand, and Narmada Valley, hot dry sub humid region.

Topography

The topography of the area plain to gently sloping. Slope of the land was nearly plane.

Climate

Study area enjoys a typical subtropical climate with hot dry summer and cool dry winter. Temperature extremes vary between minimum temperature of 46°C in May-June months. Based on 20 Years mean

meteorological data, the average annual rainfall of the locality is 1350mm, which mostly received between mid- June to end of September with an occasional winter showers during December and January months. The mean monthly minimum temperature varies between 5.3 to 6.1 in December and January, and maximum temperature varies between 40 to 42^oC during May and June, respectively January is the coldest month of the year with minimum temperature being 5^oC. Generally relative humidity remains very low during summer (20 to 23%); moderate (60 to 75%) during winter and it attains high value (80 to 95%) during rainy season.

Weather conditions during the crop season

Seasonal variations prevailing during the growth period play an important role on the growth and development of chickpea crop, which ultimately influenced the final yield and water productivity of crops. The weekly meteorological data during the course of investigation recorded at Meteorological Observatory, College of Agricultural Engineering, JNKVV, Jabalpur.

It is evident from the data that weather condition was almost favourable for the growth and development of chickpea, which ultimately influenced the final yield of crops. The monsoon was commenced in the third week of June and terminated in the last week of September. During the growing season (Nov 2019 to March 2020) maximum temperature (31.5) was recorded in the month of March. The rainfall during the crop season was 95.6 mm which had a beneficial effect on growth and development of chickpea crop.

Experimental details

To determine the water productivity of chickpea crop.

Main treatment:3

JG-14
JGG-1
JGK-1

Sub treatment

D1- 15/11/2019
D2- 30/11/2019
D3- 15/12/2019

Meteorological parameters

Daily rainfall data

The daily rainfall data during the course of investigation recorded during crop season at Meteorological observatory, College of Agricultural Engineering, JNKVV, Jabalpur.

Daily pan-evaporation data

Daily pan-evaporation data was recorded at Meteorological observatory, College of Agricultural Engineering, JNKVV, Jabalpur.

Crop parameters

Yield of chickpea
Depth of irrigation
Effective Rainfall
Total depth of water used
Water productivity of chickpea

Methodology to determine water productivity

The water productivity was worked out by dividing the yield to depth of water used.
Water productivity (kg ha⁻¹cm⁻¹) = Yield (kg ha⁻¹cm⁻¹) / depth of water used (cm)

Yield of chickpea

After threshing, biological yields and grains were separated then cleaned and weighted. Straw yield per net plot was worked out by

subtracting total grain weight from the total biomass for respective treatments. Later the grain yields per ha were computed and expressed in kg/ha.

Depth of irrigation

The depth of irrigation of chickpea was found out by the given formula

Depth of irrigation = Volume/Area

Effective rainfall

By considering daily rainfall data, mean monthly pan-evaporation data, soil properties the effective rainfall has been derived from Potential Evapotranspiration/ Precipitation Ratio Method (India) (FAO, 1974)

Irrigation

Water is supplied to all portions of field by check basin irrigation method. Irrigation water was calculated by using the water meter. It is simplest way to measure the amount of water. It means how much water should be irrigated through the pump and also known about the litre per second as rate of flowing. The average of LPS should be converted for each irrigation.

1st replication= 16000 liters

2nd replication= 17000 liters

3rd replication= 17000 litres

Total depth of water used

It includes the effective rainfall plus irrigation.

Water productivity of chickpea

Water productivity is defined as the crop production per unit amount of water used. Concept of water productivity in agricultural

production system is focused on producing more food with less water resources. It is ratio of crop yield to the amount of water applied (Irrigation+ Rainfall).

Statistical analysis

The data calculated from the experiment were tabulated and analysed statistically by method of analysis of variance as suggested by Cochran and Cox (1950).

The significance of the treatment mean square at 5% level was tested with F test.

When F test showed the significance of critical differences at 5% level further tested the differences between the treatment means.

Results and Discussion

The findings of present study were analysed and found the following details as follow.

Yield of chickpea

Yield of different varieties of chickpea

The seed yield of chickpea variety JG-14 (1387 kg/ha) was significantly superior to variety JGG-1 (1258 kg/ha) but at par to variety JGK-1 (1258 kg/ha).

Mean yield of chickpea under different dates of sowing

The mean seed yield of chickpea on sowing date 15th Nov (1426 kg/ha) was significantly superior to sowing date on 15th Dec (1147 kg/ha) but at par to sowing date on 30th Nov (1349 kg/ha).

Yield of different varieties of chickpea on 15th Nov date of sowing

Yield of chickpea variety JG-14 (1550 kg/ha) and variety JGG-1 (1426 kg/ha) and JGK-1

(1304 kg/ha) were at par. There was no significant difference.

Yield of different varieties of chickpea on 30th Nov date of sowing

Yield of chickpea variety JG-14 (1464 kg/ha) and variety JGK-1 (1302 kg/ha) and variety JGG-1 (1280 kg/ha) were at par. There was no significant difference.

Yield of different varieties of chickpea on 15th Dec date of sowing

Yield of chickpea variety JG-14 (1148 kg/ha) and variety JGK-1 (1224 kg/ha) and JGG-1 (1069 kg/ha) were at par. There was no significant difference.

Yield of chickpea selecting the most suitable combinations of dates and varieties

The different varieties of chickpea affected the seed yield at different dates of sowing. From the table it was concluded that the yield was decreasing as the date of sowing was changed. The most suitable combinations of higher yield were crop sown at 15th Nov, variety JG-14 (1550 kg/ha).

Depth of irrigation (cm)

Variety wise depth of irrigation

Depth of irrigation of chickpea variety JG-14 (5.5cm) and variety JGG-1 (5.5 cm) and JGK-1 (5.5cm) were at par. There was no significant difference between varieties.

Date wise depth of irrigation

Among sowing dates crop sown at 15th Nov (5.7 cm) was significantly superior to other dates of sowing. The sowing date of 30th Nov (5.4 cm) and sowing date on 15th Dec (5.4 cm) both were at par.

The interaction among varieties and sowing dates was found significant. The depth of irrigation of chickpea on sowing date, 15th Nov (5.7cm) was significantly superior to other dates of sowing. The depth of irrigation of chickpea on sowing date, 30th Nov (5.4cm) and sowing date on 15th Dec (5.4cm) both were at par.

Effective Rainfall (cm)

Variety wise effective rainfall

Effective rainfall of chickpea variety JG-14 (8.72cm) and variety JGG-1 (8.72cm) and variety JGK-1 (8.72cm) were at par. There was no significant difference between varieties.

Date wise effective rainfall

Among sowing dates crop sown at 15th Nov (8.97cm) and crop sown at 30th Nov (8.97cm) both were at par. Crop sown at 15th Dec (8.23cm) was significantly inferior to other dates of sowing.

Total depth of water used (cm)

Variety wise total depth of water used

Total depth of water used on chickpea variety JG-14 (14.22cm) and variety JGG-1 (14.22cm) and variety JGK-1 (14.22cm) were at par. There was no significant difference between varieties.

Date wise total depth of water used

Total depth of water used of chickpea on sowing date 15th Nov (14.67cm) was significantly superior to crop sown at 30th Nov (14.35cm) and 15th Dec (13.63cm). Total depth of chickpea on sowing date 15th Dec (13.63cm) was significantly inferior to other dates of sowing.

Table.1 Date wise grain yield of chickpea influenced by sowing dates and varieties

Treatments	Grain Yield (kg/ha)		
Sowing Dates	15 th Nov	30 th Nov	15 th Dec
Varieties			
JG-14	1550	1464	1148
JGG-1	1426	1280	1069
JGK-1	1304	1302	1224
SEm±	30	30	30
CD at 5%	94	94	94

Table.2 Variety wise grain yield of chickpea influenced by sowing dates and varieties

Treatments	Grain Yield (kg/ha)		
Varieties	JG-14	JGG-1	JGK-1
Sowing Dates			
15 th Nov	1550	1426	1304
30 th Nov	1464	1280	1302
15 th Dec	1148	1069	1224
SEm±	29	29	29
CD at 5%	117	117	117

Table.3 Date wise depth of irrigation of chickpea influenced by sowing dates and varieties

Treatments	Depth of irrigation (cm)		
Sowing Dates	15 th Nov	30 th Nov	15 th Dec
Varieties			
JG-14	5.7	5.4	5.4
JGG-1	5.7	5.4	5.4
JGK-1	5.7	5.4	5.4
SEm±	0.019	0.019	0.019
CD at 5%	0.04	0.04	0.04

Table.4 Variety wise depth of irrigation of chickpea influenced by sowing dates and varieties

Treatments	Depth of irrigation (cm)		
Varieties	JG-14	JGG-1	JGK-1
Sowing Dates			
15 th Nov	5.7	5.7	5.7
30 th Nov	5.4	5.4	5.4
15 th Dec	5.4	5.4	5.4
SEm±	0.019	0.019	0.019
CD at 5%	0.06	0.06	0.06

Table.5 Date wise effective Rainfall of chickpea influenced by sowing dates and varieties

Treatments	Effective Rainfall (cm)		
Sowing Dates	15 th Nov	30 th Nov	15 th Dec
Varieties			
JG-14	8.97	8.95	8.23
JGG-1	8.97	8.95	8.23
JGK-1	8.97	8.95	8.23
SEm±	0.03	0.03	0.03
CD at 5%	0.07	0.07	0.07

Table.6 Variety wise effective Rainfall of chickpea influenced by sowing dates and varieties

Treatments	Effective Rainfall (cm)		
Varieties	JG-14	JGG-1	JGK-1
Sowing Dates			
15 th Nov	8.97	8.97	8.97
30 th Nov	8.95	8.95	8.95
15 th Dec	8.23	8.23	8.23
SEm±	0.05	0.05	0.05
CD at 5%	0.12	0.12	0.12

Table-9 Date wise Water Productivity of chickpea influenced by sowing dates and varieties

Treatments	Water Productivity (kg/ha/cm)		
Sowing Dates	15 th Nov	30 th Nov	15 th Dec
Varieties			
JG-14	105	102	84
JGG-1	97	88	78
JGK-1	88	90	89
SEm±	2.15	2.15	2.15
CD at 5%	6.7	6.7	6.7

Table.10 Variety wise Water Productivity of chickpea influenced by sowing dates and varieties

Treatments	Water Productivity (kg/ha/cm)		
Varieties	JG-14	JGG-1	JGK-1
Sowing Dates			
15 th Nov	105	97	88
30 th Nov	102	88	90
15 th Dec	84	78	89
SEm±	2.12	2.12	2.12
CD at 5%	7.2	7.2	7.2

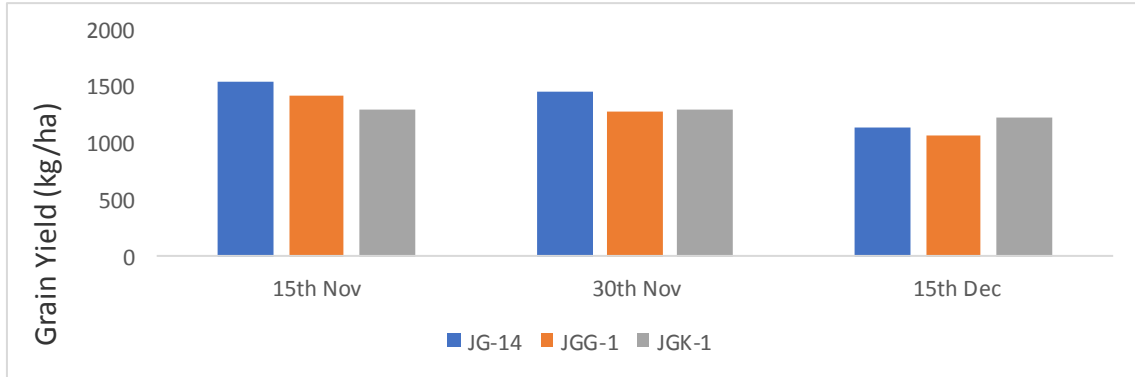


Fig.1 Grain yield of chickpea influenced by sowing dates and varieties



Fig.2 Depth of irrigation of chickpea influenced by sowing dates and varieties

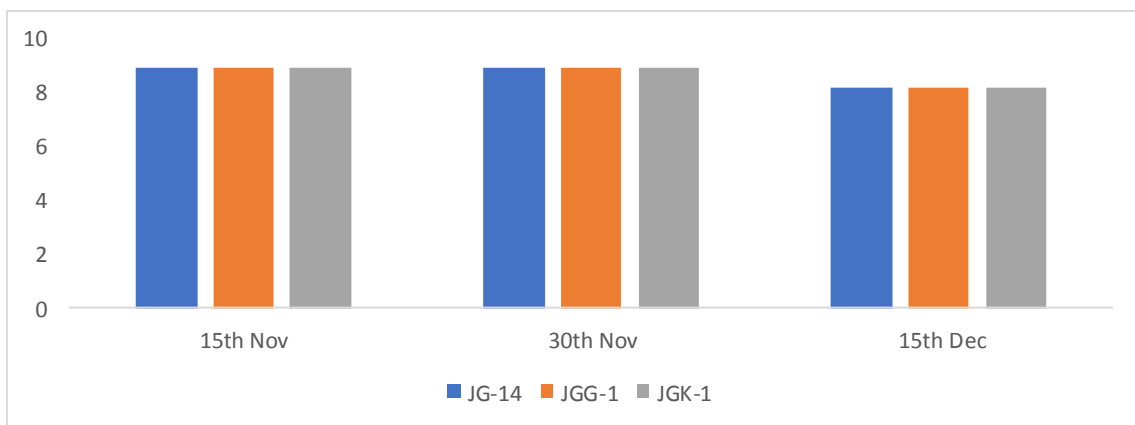


Fig.3 Effective Rainfall of chickpea influenced by sowing dates and varieties

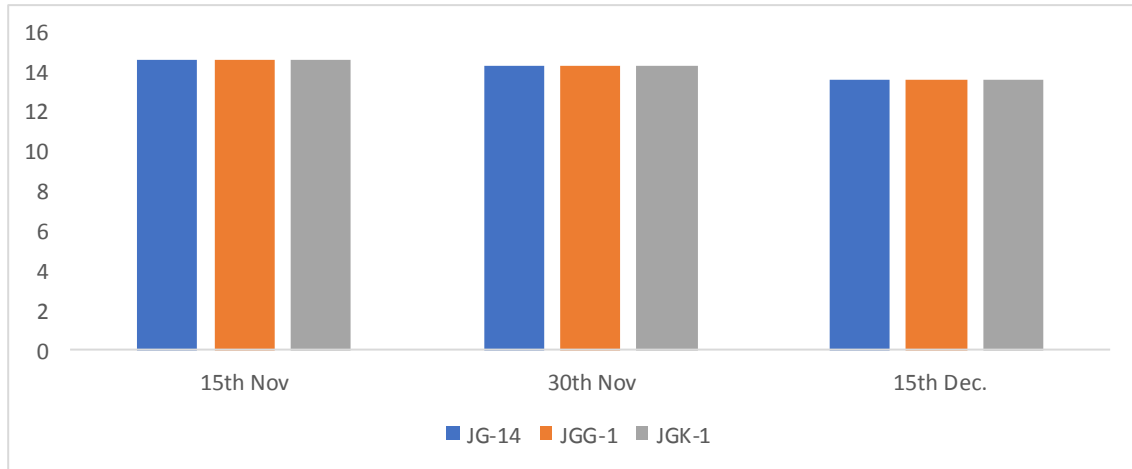


Fig.4 Total depth of chickpea influenced by sowing dates and varieties

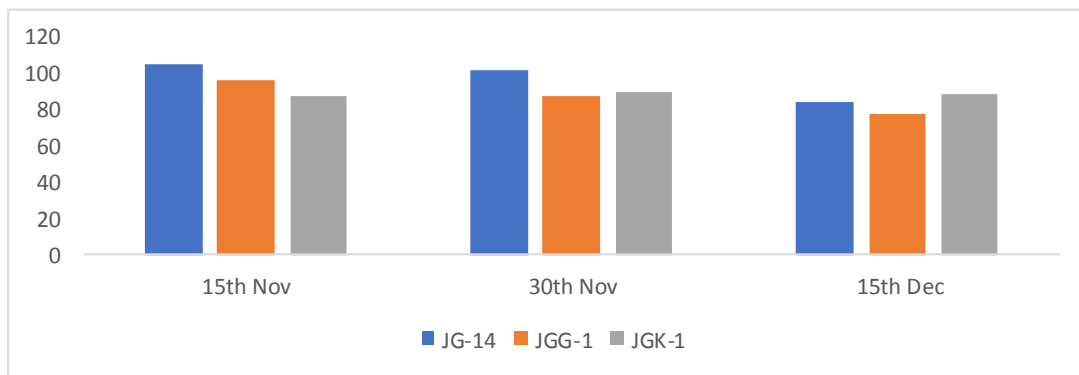


Fig.5 Water Productivity of chickpea influenced by sowing dates and varieties

Water Productivity of chickpea

WP of different varieties of chickpea

The water productivity of chickpea variety JG-14 (97 kg ha⁻¹cm⁻¹) was significantly superior to variety JGK-1 and JGG-1. The water productivity of chickpea variety JGG-1 (88 kg ha⁻¹cm⁻¹) and variety JGK-1 (89 kg ha⁻¹cm⁻¹) both were at par.

WP of chickpea under different dates of sowing

The water productivity of chickpea on sowing date 15th Nov (97 kgha⁻¹cm⁻¹) and sowing date 30th Nov (93 kgha⁻¹cm⁻¹) both were at par.

The water productivity of chickpea on sowing date 15th Dec (84 kgha⁻¹cm⁻¹) was significantly inferior to other dates of sowing.

Water productivity of different varieties of chickpea on 15th Nov date of sowing

The water productivity of chickpea variety JG-14 (105 kgha⁻¹cm⁻¹) was significantly superior to other varieties.

The water productivity of chickpea variety JGG-1 (97 kgha⁻¹cm⁻¹) was significantly superior to variety JGK-1 (88 kgha⁻¹cm⁻¹). The water productivity of chickpea variety JGK- (88 kgha⁻¹cm⁻¹) was significantly inferior to other variety.

Water productivity of different varieties of chickpea on 30th Nov date of sowing

The water productivity of chickpea variety JG-14 (102 kg $ha^{-1}cm^{-1}$) was significantly superior to other varieties.

The water productivity of chickpea variety JGG-1 (88 kg $ha^{-1}cm^{-1}$) and variety JGK-1 (90 kg $ha^{-1}cm^{-1}$) both were at par.

Water productivity of different varieties of chickpea on 15th Dec date of sowing

The water productivity of chickpea variety JGK-1 (89 kg $ha^{-1}cm^{-1}$) and variety JG-14 (84 kg $ha^{-1}cm^{-1}$) and variety JGG-1 (78 kg $ha^{-1}cm^{-1}$) were at par.

Water productivity of variety JG-14 under different dates of sowing

Water productivity of sowing date 15th Nov (105 kg $ha^{-1}cm^{-1}$) and sowing date 30th Nov (102 kg $ha^{-1}cm^{-1}$), both were at par. Water productivity of sowing dates 15th Dec (84 kg $ha^{-1}cm^{-1}$) was significantly inferior to other dates of sowing.

Water productivity of variety JGG-1 under different dates of sowing

Water productivity of sowing date 15th Nov (97 kg $ha^{-1}cm^{-1}$) was significantly superior to other dates of sowing. Water productivity of sowing date 30th Nov (88 kg $ha^{-1}cm^{-1}$) was significantly superior to crop sown at 15th Dec (78 kg $ha^{-1}cm^{-1}$). Water productivity of sowing date 15th Dec (78 kg $ha^{-1}cm^{-1}$) was significantly inferior to other dates of sowing.

Water productivity of variety JGK-1 under different dates of sowing

Water productivity of sowing date 15th Nov (88 kg $ha^{-1}cm^{-1}$) and sowing date 30th Nov (90

kg $ha^{-1}cm^{-1}$) and sowing date 15th Dec (89 kg $ha^{-1}cm^{-1}$) were at par.

Water productivity of chickpea selecting the most suitable combination of dates and variety

The different varieties of chickpea affected the water productivity at different dates of sowing. From the table it was concluded that the water productivity was decreasing as the date of sowing was changed. The most suitable combinations of higher water productivity were crop sown at 15th Nov, variety JG-14 (105 kg $ha^{-1}cm^{-1}$) and crop sown at 30th Nov (102 kg $ha^{-1}cm^{-1}$) both were at par.

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