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Performance of Chickpea Varieties on Growth and Yield through Water Absorbents under Late Sown Condition

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Abstract

This study was carried out in the winter of 2020–21 at College Research Farm Banda University of Agriculture and Technology, Banda UP, India. Experiment was conducted in split plot design with two factor-treatments and three replications with a holistic aim to search out the best variety and water absorbent that enhance the crop yield and mitigate the moisture deficit stress. The treatments consisted of main plot: three water absorbents viz., Hydrogel @ 5.0 kg ha^{-1}, two foliar application of Salicylic acid @ 150 ppm, Hydrogel @ 5.0 kg ha^{-1} followed by two foliar application of Salicylic acid @ 150 ppm and sub-plot: five varieties viz., *JG-14, JG-16, JG-18, JG-36 and RVG-202*. The conducted field study during *rabi* 2020-21 reveals that Chickpea variety "JG- 18" when sown on November 9th at a spacing of 30×10 cm^2 apart and fertilized at 25:60:30 kg of N:P:K ha^{-1} under rainfed late sown condition was performed significantly superior over other varieties irrespective of water-absorbents applied. The mixed application of water- absorbents as basal (hydrogel @ 5 kg ha^{-1}) and foliar (salicylic acid @ 150 ppm ha^{-1} twice at flower initiation and pod formation) proved remarkable in terms of growth that maximized yield. Among the treatment combination studies, the RVG-202 with the basal application of hydrogel @ 5 kg ha^{-1} and two foliar sprays of Salicylic acid @ 150 ppm at flowering initiation and pod formation significantly produced more number of root nodules at 45 and 60 DAS, took more number of days to mature and out-yielded the crop productivity.

Keywords: Chickpea, hydrogel, salicylic acid water-absorbents, variety

1. Introduction

Chickpea (*Cicer arietinum* L.), is the third most important grain legume crop in the world and first in the Mediterranean region, belongs to the family *Leguminoceae* and the genus *Cicer*. Chickpea is commonly known by Gram, Chana, and Bengal-gram. Chickpea is a low-cost vegetarian source of protein. Chickpea seed has 38 to 59% carbohydrates, 22 to 24% protein, 3% fiber, 4.8 to 5.5% oil, 3% ash, 0.2% calcium and 0.3% phosphorus (Nain et al., 2022). Digestibility of protein varies from 76 to 78% and its carbohydrate from 57 to 60 percent. India is the worlds' largest producer and consumer, both of chickpeas. In general, chickpea occupies an extensive area of 10.91 mha and produces 13.75 mt of grains with average productivity of 12.6 q ha^{-1} in the country (Anonymous, 2023).

The average yield productivity of chickpea in the country is very low when we compare it with the world's chickpea productivity (Hidoto et al., 2017). Chickpea varieties tolerant to drought stress with the highest yield potential have to be identified and developed to maximize the national average yield productivity of chickpea (Sarker et al., 2021). As of now many improved varieties of chickpea have been developed in India but their performance and yielding aptitude differ from location to location owing to specified varieties don't exhibit the same phenotypic characteristics. Variety of the crop decides its growth and yield potential under specific agro-climate along with efficient resource utilization (Maurya et al., 2022). The yield potential of different chickpea varieties may differ under different agro- climatic conditions because of their inherent capacity (Kumar et al., 2023). Variety selection is the most significant decision for a grower to maximize the crop yield by improving the fertilizer use efficiency and water use efficiency (Evans et al., 2018) Thus, adoption of improved cultivar is an important tool, which has geared production of chickpea in many states of the country. This call for a need to generate more information on the response of chickpea genotypes for greater yields in a given agro-climatic conditions (Korbu et al., 2020)

Water shortage is known as the most important limiting factor in agricultural production, especially in the sub-tropical (arid and semi-arid) regions where water resources are meager

(Meena et al., 2022). Drought stress promotes the production of reactive oxygen species, which can be detrimental to proteins, lipids, carbohydrates, and nucleic acids (Dietz and Pfannschmidt, 2011). Day by day, irrigation water is becoming limited in India and hence it is important to improve the water use efficiency of the crop-plants (Farooq et al., 2019). With improved water use efficiency, limited amount of available water can effectively be used (Deng et al., 2006). Now, it seems to be interesting to exploit the existing water potential by use of water absorbents such as soil conditioners like superabsorbent polymer at early stage and Salicylic acid at lateral stages of its growth to mitigate the declining factor productivity in general and increasing water productivity in chickpea in particular (Khateri et al., 2019). Hydrogel polymers or SAPs acts as a reservoir of water and nutrients which plants need to grow. Under rainfed conditions of terminal drought stress often prevent the crop to attain its potential productivity. (Farjam et al., 2014). Salicylic acid is involved in protecting plants from multiple stresses, including water stress, and drought stress (Patel and Hemantaranjan*,* 2012) and adjusts the activity of antioxidant enzymes, enhance plant resistance to abiotic stresses and interferes in physiological processes such as stomatal conductance in plants (Rokhzadi et al., 2014).

2. Materials and Methods

The research field was located at the College Research Farm of Banda University of Agriculture and Technology, Banda-210001, Uttar Pradesh comes under the Chitrakoot-Dham division of Bundelkhand (agro-climatic zone- 8) and it is located in the south-western part of Uttar Pradesh at latitude- 25".40˚, longitude- 80".30˚ and 141 meters above the mean sea level. The meteorological data recorded during the crop growing season showed that the average temperature maximum and minimum between 27˚C and 14.4˚C, respectively. Relative humidity ranged from 44 to 61% during the cropping period. Average wind speed was recorded 3.93 km h^{-1} during experiment period. During the period of experimentation total 13.9 mm rainfall in three rainy days received at trail location. Whereas, total evapotranspiration was 453.06 mm, which provided favorable conditions for crop growth. Initial soil fertility status of field experiment revealed soil pH 7.8, electrical conductivity 0.41 dSm^{-1}, organic carbon 0.41%, available nitrogen 190 kg ha^{-1}, available phosphorus 12.1 kg ha^{-1}, available potassium 220.42 kg ha^{-1}. The experiment was carried out in a split-plot design (SPD) and replicated thrice. The treatment kept in the main plot was a water-absorbent and had its three levels namely, 1) hydrogel @ 5.0 kg/ha, 2) two foliar applications of salicylic acid @ 150 ppm at flowering initiation and pod formation stage, and 3) basal application of hydrogel @ 5.0 kg followed by two foliar applications of salicylic acid @ 150 ppm at flowering initiation and pod formation stage. Likewise, the other treatment tested i.e. 5 varieties of chickpea, namely, JG-14, JG-16, JG- 18, JG-36 and RVG-202 was kept in subplots. The experimental field was prepared with the help of tractor-drawn implements. The stubbles of previous crops and weeds were cut into pieces by harrowing and later to provide coarse seedbed, a cross ploughing was done. The sowing of seeds was undertaken using a seed drill keeping 30 cm apart distance between the rows and later plant to plant distance was maintained at an interval of 10 cm. Application of nutrients in the formed inorganic was done as per recommended dose of fertilizers (25 kg N+60 kg P+30 kg K) per hectare were supplied as basal at time of sowing. The fertilizer was computed as per the plot size and further placed in the deep furrows opened. The weeds particularly Bathua*,* Senji*,* Motha, Gajar Grass and Satyanasi *(Argemone maxicana)* were predominantly associated in the experimental field, though pre-emergent herbicides (Pendimethalin) were applied just after 1 day of sowing. The associated weeds were kept under control up to the stage of 60 DAS by hand weeding/ hand hoe at 25–30 DAS. Nipping, is the process of removal of the top portion of a young plant (Apex bud with 2–3 leaves), stops the apical growth and promotes lateral branching, thus the plants become more vigorous and produce more flowers and pods and yield per plant is increased. In this study, nipping was done between 30–35 DAS and that helped in getting profuse branching and foliar growth during its grand growth stages. All the growth and yield attributing characters were recorded with the standard methodology at different growth stages of the crop. Various growth indices were estimated with the formulae as per mentioned below.

Recorded data was analyzed using appropriate method of 'Analysis of Variance (ANOVA)' given by Gomez and Gomez (1984).

3. Results and Discussion

3.1. Effect of treatments on growth attributing characters

Significantly maximum number of plant population at harvest) was observed in water absorbents treatment hydrogel 5 kg ha^{-1}+ salicylic acid 150 ppm. It may be due to application of both (hydrogel 5 kg ha^{-1}+ salicylic acid 150 ppm) plant motility rate decreased. Maximum plant height, numbers of branches (primary and secondary) and dry weight were recorded under treatment hydrogel @ 5.0 kg ha^{-1}+saicyclic Acid150ppm. It may be due more retention of moisture and indirectly the availability of nutrients provided by hydrophilic polymer, where it might have helped to increase the activity of cell division, expansion and elongation, ultimately leading to increased plant height, dry weight and number of branches (Yazdani et al*.,* 2007 and Farjam et al., 2015) (Table 1).

The effect of variety on plant population at harvest RVG 202 was recorded significantly maximum as compared to other varieties followed by JG 36, JG 18, JG 16, and JG 14. It may be due to less motility of RVG 202. Variety RVG-202 was recorded significantly higher plant height as compared to other varieties at harvest and. Dry matter production was also

Table 1: Effect of treatments on growth attributing characters

Treatment	Plant population		Plant height (cm)	No. of Branches		Dry Matter Accumulation (g $plant^{-1}$) at harvest
	Initial (15 DAS)	Harvest (115-125 DAS)		Primary	Secondary	
Water absorbents						
Hydrogel @ 5.0 kg ha^{-1}	12.9	10.3	45.60	4.12	8.00	19.16
Saicyclic Acid @ 150 ppm	12.9	10.3	48.03	4.10	9.43	19.99
Hydrogel @ 5.0 kg ha^{-1}+Saicyclic acid 150 ppm	13.6	11.3	51.76	4.70	10.62	21.61
SEM±	0.2	0.08	0.3	0.1	0.2	0.40
CD (p=0.05)	NS	0.5	2.0	0.6	1.0	2.44
CV (%)	6.5	2.8	2.6	8.7	6.5	7.7
Varieties						
JG 14	12.6	10.3	48.17	4.31	9.40	19.8
JG 16	12.7	10.4	47.83	4.17	9.47	19.27
JG 18	13.2	10.6	47.56	4.32	9.58	20.67
JG 36	13.6	10.6	48.87	4.44	9.26	20.04
RVG 202	13.7	11.2	50.00	4.27	9.00	21.48
SEM±	0.4	0.1	0.5	0.2	0.2	0.38
CD (p=0.05)	NS	0.4	1.5	NS	NS	1.11
CV (%)	9.7	4.2	3.7	12.2	7.9	6.5
Interaction of treatments						
SEM±	0.7	0.3	1.0	0.3	0.4	0.76
CD (p=0.05)	NS	NS	NS	NS	NS	NS

recorded maximum at harvest, because RVG 202 was taller variety and higher growth attributing characters (Singh et al. (2011). In the case of varieties, JG 36 was recorded highest no of primary branches over the JG 16; whereas varieties JG 14, JG 18, and RVG 202 were founded equally number of primary branches. JG 18 was recorded the highest number of secondary branches followed by JG 16, JG 14, JG 36, and RVG 202 (Dar, 2017).

3.2. Effect of treatments on root nodules and days to 50% flowering

At 15 DAS number of root nodules $plant^{-1}$ was not affected by water absorbents treatments because no effect of water absorbed treatment. Application of hydrogel @ 5 kg ha^{-1}+ saicyclic Acid 150 ppm was observed at 30, 45, and 60 DAS were recorded a significantly higher number of nodulation formation compared to other treatments. It might be due to Application of hydrogel @ 5 kg ha^{-1}+saicyclic Acid 150 ppm, plant growth is very fast growth and increase the activity of cell division. Similar findings have been also reported by Shinde et al. (2017). The effect of Water absorbents on 50 % flowering and days to maturity results revealed that application of hydrogel @ 5.0 kg ha^{-1}+saicyclic Acid 150 ppm was delaying 50% flowering and days to maturity followed by hydrogel @ 5.0 kg ha^{-1} and saicyclic Acid 150 ppm because increase in vegetative phase of the crop under sufficient soil moisture.

RVG 202 was recorded highest number of root nodules $plant^{-1}$ over the other varieties. JG 14 was founded maximum number of root nodules $plant^{-1}$ at 30 DAS as compared to all varieties and at 45 DAS RVG 202 was found the highest number of root nodules $plant^{-1}$. JG 14 at 60 DAS and JG 16 at 90 DAS was recorded a maximum number of root nodules $plant^{-1}$ over the other varieties. It might be due to the legume rhizobium symbiosis, rhizobia form nodules on the roots of legume hosts and fix di-nitrogen (N_2) into ammonium (NH_4+) and other chemically active forms of nitrogen. Similar result was observed by Sethi et al. (2017). Variety JG 14 was recorded early 50 % flowering because showed early phonological stages in compared to other varieties and RVG 202 was recorded early maturity followed by JG 14, JG 18, JG 16, and JG 36. It may be due to RVG 202 is short duration variety as compared to other varieties. Similar results was reported by Kabier et al. (2009) (Table 2).

Interaction effects of water absorbents and varieties on root nodules at 45 and 60 DAS were found significant.

Table 2: Effect of treatments on root nodules and days to 50% flowering

Treatment	Root nodules count					Days to 50% Flowering
	15 DAS	30 DAS	45 DAS	60 DAS	90 DAS	
Water absorbents						
Hydrogel @ 5.0 kg ha^{-1}	2.84	9.2	16.09	18.70	6.92	65.06
Saicyclic Acid @ 150 ppm	2.82	8.98	15.66	19.00	7.07	65.60
Hydrogel @ 5.0 kg ha^{-1}+ Saicyclic Acid 150 ppm	3.00	9.55	16.51	20.63	6.82	64.86
SEM±	0.2	0.17	0.30	0.53	0.28	0.2
CD (p=0.05)	NS	NS	1,82	3.22	NS	NS
CV (%)	23.4	7	7.3	10.73	15.5	0.9
Varieties						
JG 14	2.9	10.07	16.16	19.98	6.73	60.22
JG 16	2.7	9.04	14.90	18.27	7.22	67.67
JG 18	2.81	9.09	15.23	17.92	7.14	68.11
JG 36	2.82	8.91	15.40	18.11	6.65	68.56
RVG 202	3.2	9.11	18.47	21.27	6.93	61.33
SEM±	0.2	0.19	0.36	0.39	0.41	0.4
CD (p=0.05)	NS	0.56	1.06	1,12	NS	1.2
CV (%)	24.1	7.2	7.9	7.00	20.3	2.3
Interaction of treatments						
SEM±	0.4	0.38	0.72	0.77	0.81	0.9
CD (p=0.05)	NS	NS	2.22	2.25	NS	NS

Table 3: Effect of treatments on yield

Treatment	Seed Yield (q ha^{-1})	Stover Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvest Index (%)
Water absorbents				
Hydrogel @ 5.0 kg ha^{-1}	22.3	37.88	60.16	37.2
Saicyclic Acid @ 150 ppm	21.4	37.14	58.57	36.6
Hydrogel @ 5.0 kg ha^{-1}+ Saicyclic Acid 150 ppm	23.5	42.17	65.64	36.0
SEM±	0.3	1.35	1.45	0.7
CD (p=0.05)	2.0	8.21	8.83	NS
CV (%)	5.6	13.4	9.15	7.7
Varieties				
JG 14	21.1	33.71	54.83	38.6
JG 16	22.0	39.21	61.24	36.1
JG 18	22.6	40.77	63.35	35.9
JG 36	23.0	41.97	64.99	35.5
RVG 202	23.2	39.68	62.87	37.0
SEM±	0.3	0.90	0.98	0.6
CD (p=0.05)	0.9	2.63	2.86	1.7
CV (%)	4.7	7.98	5.53	5.5

Table 3: Continue...

Treatment	Seed Yield (q ha^{-1})	Stover Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvest Index (%)
Interaction of treatments				
SEM±	0.6	1.80	1.96	1.2
CD (p=0.05)	NS	5.26	5.72	NS

3.3. Effect of treatments on yield

Maximum seed yield (23.47 q ha^{-1}), harvest index, Stover yield and biological yield (64.99 q ha^{-1}) were recorded in water absorbents treatment hydrogel 5 kg ha^{-1}+ salicylic acid 150 ppm. It may be due to maximum growth attributing characters like plant height, number of primary and secondary branches, plant root nodules and yield attributing characters number of pod per plant and number of grain per pod it was contributing to yield. It was also reported by Sugui and Sugui (2002), Nagarajaiah et al. (2005) and Sethi et al. (2017).

The highest seed yield (23.19 q ha^{-1}) was recorded in variety RVG-202 which was statically at par with variety JG-36. However, the lowest seed yield (21.12 q ha^{-1}) was produced by variety JG-14. Variety JG- 36 was recorded higher straw yield and biological yield (64.99 q ha^{-1}) compared to other varieties. Variety JG-14 recorded harvest index (38.6%) and lowest harvest index (35.5%) observed in variety JG-36 compared to all other varieties. Similar result was observed by Kabier et al. (2009).

Interaction effects of water absorbents and varieties Stover and biological yield were found significant.

4. Conclusion

Chickpea variety RVG-202 performed significantly superior over other varieties irrespective of water-absorbents applied when sown on November 9th at a spacing of 30×10 cm^2 apart and fertilized at 25:60:30 kg of N:P:K per hectare under rainfed late sown condition. The mixed application of water-absorbents as basal (hydrogel @5 kg ha^{-1}) and foliar (salicylic acid @ 150ppm/ha twice at flower initiation and pod formation) proved remarkable in terms of growth parameters that maximized yield productivity.

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