Legume Research, 41(2) 2018 : 263-266
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.legumeresearch.in

# Biochemical and physiological studies on Rhizobium inoculated chickpea (*Cicer arietinum* L.) cultivar grown in eastern Uttar Pradesh

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Received: 29-04-2016 Accepted: 23-03-2017 DOI: 10.18805/lr.v0iOF.9103

## ABSTRACT

Health promoting biochemical parameters of fifteen distinct chickpea cultivar (Desi and Kabuli) showed wide variability in their biochemical and physiological composition, malic acid content, days to 50% flowering, primary branches per plant, number of pods per plant. Malic acid content polled mean ranged from 0.40 to 0.49 % in control, *rhizobium* inoculated 0.46 to 0.54% and 0.42 to 0.50% in control, *rhizobium* inoculated 0.49 to 0.54 % at 45 DAS and 90 DAS respectively, pooled mean primary branches per plant in different genotypes ranged from 4.45 to 5.70 in control and 4.90 to 6.45 in *rhizobium* inoculated chickpea genotypes, days to 50% flowering in chickpea ranged from 75.00-87.00 days in control, *rhizobium* inoculated 75.00-86.00 days, number of pods per plant in chickpea ranged from 21.98-62.91 in control, *rhizobium* inoculated 26.85-73.02. The research result about the biochemical characteristics of control and rhizobium inoculated chickpea genotypes are expected to provide guidelines for the researches confronted with the need to use such typical food seed in India as well as in the rest of the world.

**Key words:** Cultivar, Days to 50% flowering, Malic acid content, Number of pods per plant, Primary branches per plant.

## INTRODUCTION

Chickpea is ancient cultivated crop of South Asia, the middle East and the South Africa that has grown for many years in these regions (Shah *et al*., 2012). It is a rich source of proteins and provides best food of vegetarians (Yadav *et al* .,2007). It contain about 16-31.2 % proteins and 38.1-73.3 % carbohydrates (Sehirali,1988). Like other grain legumes, chickpea is a good source of mineral and vitamins. Consumption of whole seed of chickpea is desirable science its seed coat contribute about 70 % of the total seed calcium (Williams and Singh,1987).

The leaves of chickpea secretes malic acid but the significance of this secretion is not known. The PEP carboxylase activity and the secretion of malic acid are associated with the presence of glands on the surface of leaves and fruit. PEP activity increase while malic acid secretion and malic dehydrogenase activity decrease in water stress plants. However, the significant malic acid secretion in chickpea should be consider in relation to the insect pest of the plant (Koundal and Sinha, 1983).

Different chickpea varieties showed genetic variability for plant height, number of primary branches, number of secondary branches, number of pods per plant and total biological yield (Qureshi *et al*, 2004).

Besides, this medicinal importance can not over looked as scurvy patients are advised by the doctor to take germinated gram seed to get rid-off. Malic and oxalic acid collected from green, leaves of gram are prescribed for intestinal disorders (Wealth of India 1950). Germinated seeds are recommended as a prophylactic agent against deficiency, diseases. Keeping in view of above utmost importance of chickpea pertaining to human health, diversified use and insufficient inferences of the present investigation was undertaken.

## MATERIALS AND METHODS

The present investigation on "Biochemical and Physiological studies on Rhizobium inoculated chickpea (*Cicer arietinum* L.) cultivar grown in eastern U.P." was carried out at Student's Instructional Farm and in the laboratory of Department of Biochemistry during *rabi* season of 2010-11 and 2011-12. After harvesting the seeds were collected and stored in desiccators for the analysis of various biochemical parameters.

Malic acid content was determined by the method described in A.O.A.C. (1970). The total number of primary branches per plant on five plants randomly selected from each line was counted and averaged out at the line of maturity. Days to 50 % flowering was recorded as the number of days from sowing to the date on which 50 percent plants of each plot flowered. Total number of seeds bearing mature pods were counted separately from sampled five plants in each row and averaged out for single plant.

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## RESULTS AND DISCUSSION

In the year 2010-11 and 2011-12, at 45 DAS maximum malic acid content was found in genotype KWR 108 (0.49%) followed by PUSA 362 (0.48%), NDG 54 (0.47) in control (Table 1), *rhizobium* inoculated KWR 108 (0.54%), DCP 92-3 (0.54%) followed by PUSA 362 (0.53%), NDG 54 (0.53%), in 2010-11 and 90 DAS Maximum malic acid content was found in genotype KWR 108 (0.50%) followed by NDG 54, DCP 92-3 (0.49%), in control, *rhizobium* inoculated KWR 108 (0.56%) followed by PUSA 362, Pant G186 (0.54%) in 2011-12 whereas 45 DAS Minimum malic acid content were recorded in the genotype L550 (0.40%), ICCV 10 (0.42%) in control, *rhizobium* inoculated L550 (0.46%), ICCV 10 (0.48%) in the year 2010-11 and 90 DAS minimum malic acid content were recorded in the genotype genotypes L550 (0.42%), ICCV 10 (0.45%) in control, *rhizobium* inoculated L550 (0.49%), KAK 2 (0.51%) in the year 2011-12.

The result were closely supported with Wealth of India (1950), Koundal and Sinha (1983).

Maximum primary branches per plant recorded in the genotype PUSA 362 (5.60) followed by KWR 108 (5.40), H82-2 (5.30), C 235 (5.30) in control(Table 2), *rhizobium* inoculated genotypes PUSA 362 (6.30) followed by C-235 (6.20), H82-2 (6.00) in 2010-11 and PUSA 362 (5.80) followed by C 235 (5.40) KWR108 (5.30), in control, *rhizobium* inoculated genotypes C 235(6.80) followed by PUSA 362 (6.60), KWR 108 (6.20) in 2011-12. Minimum primary branches per plant were recorded in the genotype KAK 2 (4.40), L550 (4.60) in control, *rhizobium* inoculated L550 (5.00), KAK 2 (4.80) in the year 2010-11 and genotypes KAK 2 (4.50), KKG 306 (4.70) in control, *rhizobium* inoculated KAK 2 (5.00), KKG 306, BG 2083 (5.20) primary branches per plant in the year 2011-12. The result are very much supported with Togay *et al*. (2008), Qureshi *et al*. (2004).

Maximum days to 50% flowering was recorded in the control genotypes C-235 (86 days) followed by Pusa-362 (83 days), H 82-2 (82 days) while *rhizobium* inoculated genotypes C-235 (84 days) followed by Pusa-362(82 days), H 82-2 (81 days) in 2010-11 and C-235 (88 days), followed by Pusa-362 (84 days), H 82-2 (80 days) in control and *rhizobium* inoculated C-235 (87 days), followed by Pusa-362 (82 days), KKG 306 (80 days) in the year 2011-12. (Table 3). The minimum days to 50% flowering recorded in the genotype L 550, KAK 2 (75 days) in control while *rhizobium* inoculated genotypes L 550 (74 days), KAK 2 (75 days) and L 550 (74 days), KAK 2 (76 days) in control while *rhizobium* inoculated genotypes KAK 2 (74 days), L 550 (75 days) in the year 2010-11 and 2011-12 respectively. The result are closely supported with Ali Namvar *et al.* (2011).

**Table-1:** Malic acid content (%) in chickpea leaves at 45 and 90 days after sowing (DAS)

| Genotype | Malic acid content (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | | | | | | Pooled mean | | | | | |
| | 2010-11 | | | 2011-12 | | | 2010-11 | | | 2011-12 | | |
| | 45 DAS (C) | 45 DAS (R) | 90 DAS (C) | 90 DAS (R) | 45 DAS (C) | 45 DAS (R) | 90 DAS (C) | 90 DAS (R) | 45 DAS (C) | 45 DAS (R) | 90 DAS (C) | 90 DAS (R) |
| Pusa-362 | 0.47 | 0.53 | 0.48 | 0.54 | 0.46 | 0.52 | 0.47 | 0.54 | 0.48 | 0.53 | 0.48 | 0.54 |
| KWR 108 | 0.49 | 0.54 | 0.51 | 0.57 | 0.48 | 0.54 | 0.50 | 0.56 | 0.49 | 0.54 | 0.50 | 0.56 |
| H82-2 | 0.46 | 0.52 | 0.47 | 0.53 | 0.44 | 0.50 | 0.46 | 0.53 | 0.45 | 0.51 | 0.47 | 0.53 |
| NDG-54 | 0.48 | 0.54 | 0.49 | 0.55 | 0.47 | 0.53 | 0.49 | 0.55 | 0.47 | 0.53 | 0.49 | 0.55 |
| Phule 95 | 0.45 | 0.51 | 0.46 | 0.52 | 0.46 | 0.50 | 0.48 | 0.54 | 0.46 | 0.50 | 0.47 | 0.53 |
| RSG 888 | 0.46 | 0.52 | 0.48 | 0.54 | 0.45 | 0.50 | 0.47 | 0.53 | 0.45 | 0.51 | 0.48 | 0.53 |
| C-235 | 0.45 | 0.51 | 0.46 | 0.52 | 0.44 | 0.49 | 0.45 | 0.54 | 0.44 | 0.50 | 0.45 | 0.53 |
| DCP 92-3 | 0.47 | 0.53 | 0.48 | 0.55 | 0.48 | 0.55 | 0.50 | 0.55 | 0.48 | 0.54 | 0.49 | 0.53 |
| Uday | 0.44 | 0.50 | 0.46 | 0.52 | 0.45 | 0.47 | 0.46 | 0.51 | 0.44 | 0.48 | 0.46 | 0.51 |
| Pant G 186 | 0.45 | 0.51 | 0.47 | 0.53 | 0.46 | 0.51 | 0.48 | 0.55 | 0.46 | 0.51 | 0.48 | 0.54 |
| BG 2083 | 0.43 | 0.49 | 0.45 | 0.51 | 0.44 | 0.49 | 0.46 | 0.51 | 0.43 | 0.49 | 0.46 | 0.51 |
| KKG 306 | 0.46 | 0.51 | 0.48 | 0.54 | 0.47 | 0.51 | 0.49 | 0.55 | 0.46 | 0.51 | 0.49 | 0.55 |
| ICCV 10 | 0.42 | 0.48 | 0.44 | 0.50 | 0.43 | 0.48 | 0.45 | 0.51 | 0.42 | 0.48 | 0.45 | 0.50 |
| L 550 | 0.41 | 0.46 | 0.43 | 0.49 | 0.40 | 0.46 | 0.42 | 0.48 | 0.40 | 0.46 | 0.42 | 0.49 |
| KAK 2 | 0.43 | 0.49 | 0.45 | 0.51 | 0.43 | 0.49 | 0.45 | 0.51 | 0.43 | 0.49 | 0.45 | 0.51 |
| C D at 5 % | 0.09 | 0.10 | 0.12 | 0.14 | 0.11 | 0.10 | 0.13 | 0.16 | | | | |

**Table2:** Primary branches per plant in chickpea genotypes

| Genotypes | Primary branches per plant | | | | | |
|---|---|---|---|---|---|---|
| | Mean | | | | Pooled mean | |
| | 2010-11 (C) | 2010-11 (R) | 2011-12 (C) | 2011-12 (R) | (C) | (R) |
| Pusa-362 | 5.60 | 6.30 | 5.80 | 6.60 | 5.70 | 6.45 |
| KWR 108 | 5.40 | 6.00 | 5.30 | 6.20 | 5.35 | 6.10 |
| H82-2 | 5.30 | 5.90 | 5.20 | 5.70 | 5.25 | 5.80 |
| NDG-54 | 5.10 | 5.70 | 5.00 | 5.80 | 5.05 | 5.75 |
| Phule G5 | 4.90 | 5.30 | 4.70 | 5.50 | 4.80 | 5.40 |
| RSG 888 | 4.70 | 5.20 | 4.80 | 5.30 | 4.75 | 5.25 |
| C-235 | 5.30 | 6.20 | 5.40 | 6.80 | 5.35 | 6.50 |
| DCP 92-3 | 5.00 | 5.50 | 5.20 | 5.60 | 5.10 | 5.55 |
| Uday | 4.80 | 5.20 | 4.70 | 5.30 | 4.75 | 5.25 |
| Pant G 186 | 5.20 | 5.40 | 5.30 | 5.50 | 5.25 | 5.45 |
| BG 2083 | 4.70 | 5.00 | 4.60 | 5.20 | 4.65 | 5.10 |
| KKG 306 | 4.60 | 5.00 | 4.70 | 5.20 | 4.65 | 5.10 |
| ICCV 10 | 4.77 | 5.10 | 4.90 | 5.40 | 4.83 | 5.25 |
| L 550 | 4.60 | 5.00 | 4.90 | 5.30 | 4.75 | 5.15 |
| KAK 2 | 4.40 | 4.80 | 4.50 | 5.00 | 4.45 | 4.90 |
| C D at 5 % | 1.25 | 1.55 | 1,27 | 1.59 | | |

**Table 3:** Days to 50 per cent flowering in chickpea genotypes

| Genotypes | Days to 50 per cent flowering | | | | | |
|---|---|---|---|---|---|---|
| | Mean | | | | Pooled mean | |
| | 2010-11 (C) | 2010-11 (R) | 2011-12 (C) | 2011-12 (R) | (C) | (R) |
| Pusa-362 | 83.00 | 82.00 | 84.00 | 82.00 | 83.00 | 82.00 |
| KWR 108 | 78.00 | 76.00 | 77.00 | 75.00 | 78.00 | 76.00 |
| H82-2 | 82.00 | 81.00 | 80.00 | 78.00 | 81.00 | 80.00 |
| NDG-54 | 77.00 | 76.00 | 78.00 | 76.00 | 78.00 | 76.00 |
| Phule G5 | 77.00 | 76.00 | 78.00 | 76.00 | 78.00 | 76.00 |
| RSG 888 | 78.00 | 77.00 | 76.00 | 77.00 | 77.00 | 77.00 |
| C-235 | 86.00 | 84.00 | 88.00 | 87.00 | 87.00 | 86.00 |
| DCP 92-3 | 81.00 | 80.00 | 82.00 | 80.00 | 81.00 | 80.00 |
| Uday | 80.00 | 79.00 | 81.00 | 79.00 | 80.00 | 79.00 |
| Pant G 186 | 77.00 | 76.00 | 76.00 | 75.00 | 77.00 | 76.00 |
| BG 2083 | 79.00 | 78.00 | 77.00 | 76.00 | 78.00 | 77.00 |
| KKG 306 | 79.00 | 78.00 | 82.00 | 80.00 | 81.00 | 79.00 |
| ICCV 10 | 76.00 | 75.00 | 77.00 | 75.00 | 77.00 | 75.00 |
| L 550 | 75.00 | 74.00 | 74.00 | 75.00 | 75.00 | 75.00 |
| KAK 2 | 77.00 | 75.00 | 76.00 | 74.00 | 77.00 | 75.00 |
| C D at 5 % | 10.00 | 9.00 | 10.00 | 10.00 | | |

**Table 4:** Number of pods per plant in chickpea genotypes

| Genotypes | Number of pods per plant | | | | | |
|---|---|---|---|---|---|---|
| | Mean | | | | Pooled mean | |
| | 2010-11 (C) | 2010-11 (R) | 2011-12 (C) | 2011-12 (R) | (C) | (R) |
| Pusa-362 | 62.32 | 72.21 | 63.50 | 73.83 | 62.91 | 73.02 |
| KWR 108 | 58.32 | 67.43 | 56.80 | 68.24 | 57.56 | 67.84 |
| H82-2 | 56.80 | 66.74 | 55.80 | 67.33 | 56.30 | 67.04 |
| NDG-54 | 58.24 | 67.54 | 58.82 | 68.35 | 58.53 | 67.95 |
| Phule G5 | 55.74 | 64.34 | 54.80 | 63.72 | 55.27 | 64.03 |
| RSG 888 | 53.42 | 63.83 | 55.20 | 67.46 | 54.31 | 65.65 |
| C-235 | 60.21 | 69.51 | 60.50 | 70.83 | 60.36 | 70.17 |
| DCP 92-3 | 55.63 | 62.22 | 58.30 | 61.41 | 56.97 | 61.82 |
| Uday | 55.23 | 61.43 | 56.20 | 60.82 | 55.72 | 61.12 |
| Pant G 186 | 44.32 | 52.21 | 46.20 | 57.64 | 45.26 | 54.93 |
| BG 2083 | 23.65 | 26.12 | 25.31 | 30.52 | 24.48 | 28.32 |
| KKG 306 | 23.52 | 26.32 | 22.31 | 27.63 | 24.92 | 26.98 |
| ICCV 10 | 39.83 | 45.56 | 35.57 | 47.21 | 37.70 | 46.39 |
| L 550 | 24.50 | 28.32 | 26.32 | 30.34 | 25.41 | 29.33 |
| KAK 2 | 22.54 | 26.35 | 21.42 | 27.35 | 21.98 | 26.85 |
| C D at 5 % | 10.21 | 10.85 | 10.27 | 10.90 | | |

Maximum pods per plant was recorded in the genotype PUSA 362 (62.32) followed by C 235 (60.21) KWR 108 (58.32) in control, (Table 4) *rhizobium* inoculated genotypes PUSA 362 (72.21) followed by C-235 (69.51), NDG 54 (67.54) in 2010-11 and PUSA 362 (63.50) followed by C 235 (6050), NDG 54 (58.82) in control, *rhizobium* inoculated genotypes PUSA 362 (73.83) followed by C 235 (70.83) KWR 108 (68.24) in 2011-12. Minimum pods per plant were recorded in the genotype KAK 2 (22.54), KKG 306 (23.52) in control, *rhizobium* inoculated KKG 306 (26.32), KAK 2 (26.35) in the year 2010-11 and genotypes KAK 2 (21.42), KKG 306 (22.31) in control, *rhizobium* inoculated KAK 2(27.35), KKG 306 (27.63) pods per plant in the year 2011-12. The results indicate to close favour with Togay *et al*. (2008), Ali Namvar *et al.* (2011).

## CONCLUSIONS

The variations due to genotypes have been screened out by exploring parameters and found suitability of wide uses of desi and kabuli chickpea. It has resulted most promising varieties *viz*., desi and Kabuli rhizobium inoculated genotype PUSA 362, KWR 108 and H 82-2. Among these, PUSA 362was found highest enriching of malic acid content, days to 50% flowering, primary branches per plant, number of pods per plant. In regard, desi chickpea varieties also augmented new facts on the nutritional aspect in Pusa 362, and KWR 108. Interestingly Pusa 362 variety encountered rich quantum of carbohydrate, days to 50% flowering, number of pods per plant thereby, it might be recommended for the users at growing and healthy age group of people.

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