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Performance of Chickpea Varieties under Rainfed Black Soils of Chamarajanagara District, Karnataka (Zone-6)

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ABSTRACT

Background: The major constraint in rainfed chickpea cultivation is unavailability of short duration, wilt resistant and high yielding varieties in Chamarajanagara district. In this regard, an investigation was carried out to identify suitable high yielding varieties for Chamarajanagara District, Karnataka (Zone-6).

Methods: As a part of on farm testing of ICAR-KVK, Chamarajanagara conducted a field experiment during *rabi* 2018-19, 2019-20 and 2020-21 (Three years) in farmers field at Kotamballi village. Four chickpea varieties *viz*., Annigere-1, JG-11, Jaki-9218 and BGD-103 were tested under randomized complete block design (RCBD) which was replicated seven times.

Result: The study revealed that chickpea variety BGD-103 recorded significantly higher grain yield (14.28 q/ha) and per cent protein content (20.10%) with the minimum disease incidence of 7.93 per cent. The growth and yield parameters were also better with BGD-103 variety as compared to other varieties. The highest wilt incidence of 29.2 per cent was recorded with chickpea variety A-1 followed by JG-11 (26.09%). The highest net return of `.35703/ha and benefit cost ratio of 2.16 was recorded in BGD-103 compared to other varieties. The investigation revealed that BGD-103 was found to be suitable variety for rainfed black soils of Karnataka (Zone-6) due to minimum wilt incidence, short duration nature, higher seed yield and per day productivity.

Key words: Chickpea, Duration, Productivity, Wilt, Yield.

INTRODUCTION

Among different legumes chickpea occupies the third position in the world after dry beans and dry peas. Ali and Kumar (2001) has quoted that nearly 90% of the global area and production is mainly confined to Asia. Further, it is also being grown in the Mediterranean Region, the West Asian and North African Region, North and Central America and Eastern Africa. Recently, it has expanded to Australia and Canada. In semi-arid tropics and in spring and winter seasons in the temperate and Mediterranean types of climate, chickpea has grown mostly as a rainfed crop under conserved moisture in the post rainy season (Ali and Kumar, 2001).

Chickpea (*Cicer aritinum* L.) is an important leguminous crop used in preparation of wide variety of foods in several developing countries including India as a source of highly digestible (70-90%) dietary protein. Chickpea plays a significant role in improving soil fertility by fixing the atmospheric nitrogen (Kuldeep Balai, 2017). In India, chickpea occupies an area of 9.40 million ha. with a production and productivity of 10.13 million tones and 1073 kg/ha, respectively. In South India, the average yield of chickpea is only 50% to that of in North India. In Karnataka, chickpea occupies an area of 1.09 million ha. with a production and productivity of 0.57 million tones and 525 kg/ha, respectively.

In Karnataka, Chamarajanagara is a boarder district with a wide versatility in climate and diversification of crops. Among different pulses, chickpea occupies an area of 2780 ha next to horse gram (15386 ha), green gram (3265 ha) and black gram (2961 ha). The productivity of chickpea in district is 328 kg/ha. There is a yield gap of 197 and 745 kg/ha respectively when compared to state and national productivity.

The reasons for very poor productivity is erratic rainfall (Particularly terminal drought) and growing of long duration local varieties susceptible for wilt caused by *Fusarium oxysporum* f. sp. *ciceris* which has led to huge yield loss of 37-45% (Veeramani and Sendhilvel, 2020). *Fusarium oxysporum* f. sp. *ciceris* is a facultative saprophyte and can

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survive in soil up to six years in the absence of susceptible host. Most of the resistant varieties have been found to be susceptible after some years because of breakdown in their resistance and evolution of new races of the pathogen (Ayyub *et al.,* 2003). This has led to drastic decrease in chickpea area of Chamarajanagara district. In this context, the present study was undertaken to evaluate four different chickpea varieties suitable for rainfed conditions of Chamarajanagara district.

MATERIALS AND METHODS

As a part of on farm testing, ICAR-KVK, Chamarajanagara conducted a field experiment from 2018-19, 2019-20 and 2020-21 (Three years) in farmers field at Kotamballi village, Chamarajanagara taluk and district located in the Southern Dry Zone of Karnataka. The soil of the experimental site was medium black soil in texture and with a pH of 8.37. The soils were less in available nitrogen (167.3 kg/ha) and potassium (189.6 kg/ha) and medium in phosphorus (18.1 kg/ha). The organic carbon content was low in range (0.49%). An experiment was replicated seven times in randomized complete block design (RCBD).

The experimental plots were deep ploughed with two harrowing prior to sowing during 2018-19. Three harrowings were done prior to sowing during 2019-20 and 2020-21. The chickpea cultivars were sown at a depth of 5 cm and 10 cm plant-plant and 30 cm row-row spacing. Weeds were controlled manually. Nitrogen, phosphorus, potassium and zinc sulphate were applied to each plot at the time of sowing as per the recommendation of University of Agricultural Sciences, Bengaluru package of practice. The experiment included four varieties Annigere-1: Farmers growing local and susceptible variety to wilt; JG-11: Resistant to wilt, moderately resistant to root rot and bold seeded released from UAS, Bengaluru. The Jaki-9218: Resistant to wilt, root rot and collar rot released from PDKV, Akola and BGD-103: Bold seeded and resistant to wilt released from UAS, Raichur.

The rainfall received during 2018, 2019 and 2020 was 83.8%, 137% and 130.5% respectively of the normal mean annual rainfall. Mean annual rainfall for this region is 730 mm (Table 1). The crop season rainfall varied from 99.3 mm to 294.8 mm with a rainy days of 54 to 62. During 2018 rainfall received and number of rain days was less than the normal. Whereas, during 2019 and 2020 sufficient rainfall was received with normal distribution.

Randomly five plants were selected from individual plot for recording observation. Number of days taken to attain 50 per cent flowering was recorded by counting the total number of days taken for 50 per cent of the total population to reach flowering stage, number of days taken to attain physiological maturity was recorded by counting number of days required by the entire plants to reach yellow and dry stage, number of pods per plant was recorded by counting the total number of pods per plant, seed yield by taking the total net seed yield plot from each variety. The periodical observations on growth and yield contributing characters of chickpea and wilt incidence economics of all the varieties were recorded as per the procedure outlined by Veeramani and Sendhilvel (2020).

Per cent wilt incidence=

$$\frac{\text{Number of plants showing disease symptoms}}{\text{Total number of plants assessed}} \times 100$$

Protein content in chickpea was analysed as per the procedure outlined by François Mariotti *et al*. (2008). The gross returns (Grain yield was multiplied by market price per quintal) was calculated based on the market price prevailing. The net return was computed by subtracting the gross return from total cost of cultivation (Ajay Kumar *et al*., 2022). Further the Benefit-cost ratio was computed by dividing the gross returns (`/ha) by total cost of cultivation (`/ha) (Samapika Dala *et al*., 2022).

Statistical analysis

The experimental data collected on various growth, yield and other aspects were subjected to Fisher's method of analysis of variance (ANOVA) as per methods outlined by Gomez and Gomez (1984). Critical difference (CD) was calculated wherever the 'F' test was found significant. The data are presented with the level of significance at 5 and 1%. The data on Per cent wilt incidence was subjected to arcsine transformation as suggested by Gomez and Gomez (1984) before statistical analysis. Correlation studies were made between grain yield of chickpea and its yield attributes. The values of correlation coefficient (r) were calculated and tested for their significance as per the procedure outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth parameters

The phenotypic expression and grain yield are actually governed by vegetative growth, which is one of the important growth stages. The height of plants, primary branches and secondary branches are the main attributes for estimation of vegetative growth and has a specific function (Jan *et al*., 2020). Chickpea variety BGD-103 has recorded significantly higher plant height (40.29 cm) and was statistically at par with the Jaki-9218 (38.61 cm), JG-11 (38.14 cm) and A-1 (38.04 cm). The number of primary branches varied from 4.08-4.74, respectively. The primary branches were significantly higher with the Jaki-9218 (4.74) followed by BGD-103 (4.25) and other varieties (Table 2). The highest secondary branches were recorded with Jaki-9218 (17.80) followed by A-1 (16.10), BGD-103 (15.70) and JG-11 (15.20). However, the highest dry matter production of 45.70 g/plant was observed with BGD-103 as compared to other varieties, which varied from 41.1-42.28 g/plant respectively. The results were in agreement with the findings of Patil *et al.* (2015) and Alkadev *et al.* (2017).

Fusarium wilt incidence

Among the four types of chickpea varieties screened against *Fusarium* wilt (Table 2), the highest percentage of incidence

Table 1: Rainfall and its distribution during study period.

Particulars	2018	2019	2020
Mean annual rainfall (mm)	730	730	730
Annual rainfall during (mm)	611.7	1001.1	952.9
Percentage of mean annual rainfall	83.8	137	130.5
Crop season rainfall (mm)	99.3	294.8	238.7
Number of rainy days in the year	54	62	56
Number of rainy days during cropping season	08	20	11
Date of sowing of chickpea varieties	12.10.2018	10.10.2019	17.10.2020
Date of harvest of chickpea varieties	2nd-14th January 2019	6th-14th January 2020	11th January-2nd February 2021

Table 2: Growth attributes of chickpea varieties under rainfed conditions of Chamarajanagara District, Karnataka (Pooled data of 3 years).

Varieties	Plant height (cm)	No. of primary branches	No. of secondary branches	Dry matter production (g/plant)	Per cent wilt incidence
A-1	38.04±1.38	4.08±0.57	16.10±0.58	41.10± 0.87	0.296±0.012 (29.20)
JG 11	38.14±1.36	4.21±0.43	15.20±0.80	41.90±0.59	0.264±0.012 (26.09)
Jaki-9218	38.61±0.86	4.74±0.45	17.80±1.01	42.28±0.62	0.098±0.004 (09.80)
BGD-103	40.29±1.41	4.25±0.36	15.70±0.55	45.70±2.08	0.079±0.006 (07.93)
S.Em.±	0.59	0.13	0.38	1.05	0.003
CD (P=0.05)	1.66	0.36	1.07	2.96	0.009

Values in parenthesis are original values.

was recorded from the variety A-1 (29.20%) followed by JG-11(26.09%) and the lowest incidence was observed with the variety BGD-103 (7.93%) and Jaki-9218 (9.80%). In new varieties of chickpea the degree of genetic potential for disease resistance is higher than old varieties. The cultivation of resistant cultivars was the most effective and economical way for controlling the wilt disease. This may be due to having multiple genes of resistance to this descriptive disease (Demissew, 2010 and Veeramani and Sendhilvel, 2020).

Days to 50 per cent flowering and physiological maturity

The number of days taken to 50% flowering and physiological maturity varied significantly among all the varieties (Table 3). The varieties with a short life span would reach flowering and maturity within short periods compared to long duration varieties. In the present study, the variety BGD-103 has recorded significantly less number of days (43 days) for attaining 50 per cent flowering as well as physiological maturity (83.3 days) whereas the A-1 variety has taken longer time for both 50 per cent flowering (51.7 days) and physiological maturity (97.7 days).

Yield and yield parameters

A significant difference in number of pods per plant was observed among the varieties of chickpea (61.9 to 53.7) and the results are given in Table 3. The Jaki-9218 variety (61.9) has recorded significantly more number of pods followed by JG-11 (57.3), BGD-103 (55.3) and A-1 (53.7) varieties. This variation might be due to varietal characters. The variation in number of pods per plant was found due to the variation in number of branches production and the genetic variations of the varieties (Kabir *et al.,* 2008). However, the 100 seed weight (34.44 g) was highest with BGD-103 as compared to other varieties. Further the grain yield per plant also followed the similar trend as obtained in case of 100 seed weight (Table 3).

The grain yield varied from 14.28 to 9.52 q/ha, respectively among the chickpea varieties (Table 3). The highest grain yield was recorded with BGD-103 (14.28 q/ha) which was at par with Jaki-9218 (13.48 q/ha). Further, the lowest yield of 9.52 q/ha was recorded with the farmers variety (A-1). Increase in yield of improved varieties is mainly attributed to better vegetative growth with greater total dry matter production, grain yield per plant and reduced incidence of fusarium wilt over local variety (A-1). Further the haulm yields of improved varieties of BGD-103 and Jaki-9218 followed the similar trend as in case of grain yield and it was attributed to better vegetative growth with higher dry matter accumulation per plant (Patil *et al.,* 2016).

Productivity per day

In short duration varieties productivity per day will plays an important role. The results revealed that a significant difference in per day productivity was observed among varieties (Table 3). BGD-103 variety recorded significantly higher per day productivity of 17.13 kg/ha where as the lowest was recorded with A-1 variety (9.75 kg/ha). This might be due to the early maturing nature of BGD-103, which has helped in escaping the adverse effects of biotic and abiotic stresses at the end-of-season resulted in relatively higher productivity (Jagdish Kumar *et al*., 1996).

Protein content

The protein content among the varieties varied significantly (Table 3). The highest protein content of 20.1% was recorded

Table 3: Yield attributes of chickpea varieties under rainfed conditions of Chamarajanagara District, Karnataka (Pooled data of 3 years).

Varieties	Days taken for 50% flowering	Days taken for maturity	No. of pods per plant	100 seed weight (g)	Grain yield per plant (g)	Grain yield (q/ha)	Haulm yield (q/ha)	Productivity per day (kg/ha)	Protein content (%)
A-1	51.67±0.36	97.67±1.41	53.7±1.42	22.58±0.29	13.86±0.42	9.52±0.58	12.38±0.53	09.75±0.641	19.52±0.015
JG 11	51.33±0.64	96.33±1.23	57.3±2.58	24.42±0.28	14.15±1.07	10.12±0.37	13.98±0.51	10.49±0.313	19.49±0.034
Jaki-9218	49.67±1.19	88.67±1.58	61.9±0.86	23.42±0.56	14.33±0.50	13.48±0.57	17.67±0.92	15.27±0.772	19.22±0.027
BGD-103	43.33±2.18	83.33±0.72	55.3±2.36	34.44±0.13	15.48±0.69	14.28±0.78	18.41±0.67	17.13±0.977	20.10±0.081
S.Em. ±	0.43	0.50	0.76	0.16	0.34	0.30	0.28	0.34	0.023
CD (P=0.05)	1.22	1.41	2.15	0.45	0.98	0.85	0.81	0.95	0.066

Table 4: Correlation between grain yield, growth and yield components of chickpea variety as influenced by different varieties (Pooled date of 3 years).

Parameters	Grain yield (q/ha)	Dry matter production (g/plant)	No. of secondary branches	No. of primary branches	Plant height (cm)	Grain yield per plant (g)	100 seed weight (g)	No. of pods per plant	Per cent wilt incidence
Grain yield (q/ha)	1								
Dry matter production (g/plant)	0.8085**	1							
No. of secondary branches	0.4167**	-0.1763**	1						
No. of primary branches	0.6122**	0.0486**	0.8589**	1					
Plant height (cm)	0.8357**	0.9911**	-0.0886**	0.0783**	1				
Grain yield per plant (g)	0.8287**	0.9994**	-0.1447**	0.0845**	0.9916**	1			
100 seed weight (g)	0.6836**	0.9818**	-0.3430**	-0.1415**	0.9659**	0.9744**	1		
No. of pods per plant	0.5405**	-0.0983**	0.7250**	0.9523**	-0.1032**	-0.0638**	-0.2750**	1	
Per cent wilt incidence	-0.9976**	-0.7681**	-0.4668**	-0.6652**	-0.7960**	-0.7903**	-0.6337**	-0.4942**	1

**Correlation is significant at P=0.01.

Table 5: Economics of chickpea varieties under rainfed conditions of Chamarajanagara, Karnataka (Pooled data of 3 years).

Varieties	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
A-1	30889	42749	11860	1.38
JG 11		46600	15711	1.51
Jaki-9218		61827	30938	2.00
BGD-103		66592	35703	2.16

with BGD-103 which was significantly on par with A-1 (19.52%) and JG-11 (19.49%). Whereas, the lowest protein content of 19.22% was recorded with the chickpea variety Jaki-9218.

Correlation among growth and yield components

Correlation of grain yield with growth and yield parameters was presented in Table 4. Correlation studies also revealed a significant and positive association between plant height (r= 0.8357**), Number of primary and secondary branches (r= 0.6122**and 0.4167**, respectively) and dry matter production (r= 0.8085**). Whereas significant and strongly a negative association was observed with grain yield and per cent wilt incidence (r= -0.9976**). Further a significant and positive association was observed with number of pods per plant (r= 0.5405**), 100 seed weight (r= 0.6836**) and grain yield per plant (r= 0.8287**). The correlation results observed in this study agree with the results of earlier studies recorded by Kumar *et al.* (2002) and Patil *et al.* (2016).

Economics

Among the chickpea varieties, higher yield and market preference was given to BGD-103 variety due to its bold seeds and hence fetched higher prices. The BGD-103 recorded the highest net profit of `. 35703/ha with the benefit to cost ratio of 2.16 followed by Jaki-9218 (`.30938/ha and 2.00, respectively) while the local check registered the lowest net profit of `.11860/ha and benefit cost ratio of 1.38 (Table 5). Srinivas *et al.* (2005) and many other researcher reported similar effects on economic parameters.

CONCLUSION

The varietal experiments conducted during three consecutive years (2018, 2019 and 2020) showed that the

BGD-103 is an early maturing variety coupled with wilt resistance. Further, these varietal characteristics have helped in getting higher grain yield and per day productivity under rainfed black soils of Chamarajanagara district of Karnataka (Zone-6).

Conflict of interest

All authors declared that there is no conflict of interest.

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