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Research Article

Performance of Chickpea (*Cicer arietinum* L.) Genotypes in Sunsari district of Province no. 1 Nepal

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ABSTRACT
The present study was carried out to know the performance of growth, yield contributing characters, and reaction against insect pests and disease on chickpea genotypes at Jute Research Program, Itahari, Sunsari, Nepal. A total of twelve chickpea genotypes were sown in Randomized Complete Block Design (RCBD) with three replications and each replicate had 10 lines with an inter and intra row spacing of 40 cm and 10 cm respectively. It is of great interest to consider the per se performance of different genotypes on various characters of economic importance, particularly earliness, plant height, nodule number, pod number, seed diameter, 100 seed weight, seed yields, pest and disease incidence. The genotypes ICCV-87312 showed earlier in flowering and maturity while the genotypes KWR-108 and Tara showed the highest and lowest plant height respectively. Likewise, the yield and yield components of overall pooled mean performance of chickpea genotypes ICCV-840508-38 born the maximum pod number, seed diameter, hundred seed weight, and seed yields. With respect to pest incidence, genotype KWR-108 was found to be less susceptible while genotype Tara was found to be more susceptible against pest damage (pod damage). Similarly, the genotypes ICCV-87312 found to be less susceptible while genotypes ICCV-98937 were found to be more susceptible against fusarium wilt disease among the tested genotypes. On the basis of the mean performance of yield components and biotic stress components observed in the present study, the five genotypes viz., ICCV-840508-38, ICCV-98933, KPG-59, ICCV-87312, and KWR-108 were found to be superior genotypes. Therefore, farmers and chickpea producers around study areas and similar agro-ecologies can use those genotypes for chickpea production as well as these materials can be used for the further breeding programs too.
Keywords: Chickpea, Genotypes, Yields, Insect pest, Disease etc.

INTRODUCTION
Legume crops are an essential part of the daily diet for people in many developing countries where a larger proportion of the population cannot afford animal products. Chickpea (*Cicer arietinum* L.) is an important legume crop widely distributed and cultivated throughout the globe. Chickpea commonly known as Chana in Nepal is an important and unique food riched in carbohydrates, dietary fiber, and protein, and the protein quality is considered to be better than other pulses (Jukanti et al., 2012). It is an important legume to the population, as it is the primary protein source for nearly 2 million Nepalese people (Pande et al., 2005). Besides being an important source of human and animal food, chickpea also plays an important role in the maintenance of soil fertility, particularly in dry, rain-fed areas (Saxena, 1990 and Katerji et al. 2001). Globally, the chickpea is cultivated on about 11.08 million ha adding 9.77 million tons of grains to the global food baskets with average productivity of 882 kg ha-1. The chickpea is the third most important grain legume in the world after dry beans and dry peas. Its cultivation is mainly confined to Asia with 90% of the global area and production (Ali and Kumar 2001). In Nepal, it is the second most important pulse crop after lentil and predominantly grown under rain-fed conditions which

occupy 9653 ha of areas with the production of 10675 Mt (AICC, 2020). Chickpea faces diverse environments for its production in terms of photoperiod, temperature, and precipitation, all of which have a profound effect on growth and development (Khanna-Chopra and Sinha 1987). Chickpea is grown in tropical, subtropical, and temperate regions. It is a valued crop and provides nutritious food for an expanding world population and will become increasingly important in the context of climate change. Chickpea is an important winter legume grown mainly in the rainfed area of Nepal, mainly in rice or maize-based ecosystem either as a sole or mixed crop with other winter crops.

The average productivity of chickpea in Nepal is much lower than the world's average and is also lower as compared to other chickpea-growing countries of Asian regions. There are many factors responsible for low yield, but among those factors use of traditional or low yielding varieties and poor adoption of management practices are considered most important. Nonetheless, chickpea production is being constrained due to several biotic and abiotic stresses worldwide. Among the biotic stresses, fusarium wilt, ascochyta blight, pod borer, cutworm, and abiotic stresses such as drought, heat, soil salinity, low soil fertility, and poor crop management practices are the most important limiting factors in crop production. Improvement in yield and quality of the crop is the primary objective and selection of superior plants is the basis of crop improvement. The efficiency of selection depends on the identification of genetic variability from the phenotypic expression of the characters. Estimation and use of genetic diversity of the available genetic resources are key factors for a successful breeding program (Renganayaki et al., 2001) aimed at improving crop performance under biotic and abiotic stresses. Therefore, this study was incited with the objective to test the performance of chickpea genotypes for their adaptability on growth, yield and yield-related traits, pest, and disease incidence in the study areas.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Jute Research Programm, Itahari, Sunsari (at 26o15' north latitude and 87o 20' east longitude) during two successive growing periods in 2018 and 2019. A total of twelve chickpea genotypes were sown in Randomized Block Design (RBD) with three replications and each replicate had 10 lines with an inter and Intra row spacing of 40 cm and 10 cm respectively. Individual plot size was 4m x 2.4 m =9.6 m2 and 1 m and 1.5 m between plot and block respectively. Seeds of chickpea genotypes were collected from the National Grain Legumes Program, Khajura, Banke. The seed was sown in rows on the trail plot and placed at 2-3 cm depth in each row. Two seeds were sown in each hill. The recommended dose of fertilizer was applied at the time of planting. All other agronomic management was applied uniformly in all experiment plots as per the national recommendation for the crop. Observation and data collection was carried out from the experiment fields. Data were collected during the experiment time both from the whole plot, net plot, and sampled plants by random selection from the middle of four rows of each plot. Observations on the following quantitative and qualitative characters were recorded on ten randomly selected plants from each plot in each replication. These plants were tagged before flowering. The data were recorded on Days to emergence, Days to 50% flowering, Days to maturity, Early plant stand, Final plant stand, Plant height (cm), Branch number, Nodule number, pod number per plant, seed number per pod, seed diameter (mm), 100 seed weight (gm), seed yields (ton/ha), pest and disease incidence (%). The incidence of pests (pod borer) was recorded at the time of maturity. All the pods of 10 randomly selected plants were plucked and number of healthy and damaged pods were counted and percent pod damage was calculated by using the following formula,

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Similarly, field observations of naturally occurring fusarium wilt incidence were done at 7- day interval at sick plot based on percent of wilt incidence in each plot. Initial recording data for fusarium wilt disease incidence was done when wilting symptoms were visible on the three to five basal leaves of the plants. Disease incidence (DI) on each experimental unit was calculated by using the following formula:

$$\text{DI (\%)} = \frac{\text{Number of plants that show wilt symptoms}}{\text{Number of both disease infected plants and healthy plants}} \times 100.$$

Analysis of variance (ANOVA) was computed for grain yield and other traits as per the methods described by Gomez and Gomez using Genstat 15th edition computer software for Randomized Complete Block Design.

RESULTS AND DISCUSSION

Crop phenology

Statistical analysis of crop phenology data showed the significant ($P \leq 0.05$) difference in both the year's aspects days to emergence among the tested twelve chickpea genotypes. The flowering duration of testing genotypes ranges from 82 to 92 and 85 to 96 days while the maturity days range from 126 to 135 and 143 to 153 days respectively during two successive growing seasons. The mean performances for these traits are presented in Table-1. The chickpea genotypes showed early flowering and maturity at first, growing season as compared to the second growing season. This might be due to differences in the day length and temperature of the two growing seasons. The pooled mean over a year for flowering and maturity days ranges from 84 to 93 and 138 to 143 days respectively. The earliest 50% flowering was observed from genotypes ICCV-87312 (84 days), while later flowering was observed from genotypes ICCV-97207 (93 days). Similarly, the early maturing genotypes were observed from genotypes ICCV-87312 and KPG-59 (138 days), while later maturing was observed from the genotypes ICCV-98937 and Tara (143 days) among the tested genotypes (Table 1). Similar results for the mean and range for days to 50% flowering and days to maturity in chickpea genotypes were reported by (Jakhar et. al. 2016) that days to 50% flowering ranges from 51.67 to 82.67 days and days to maturity ranges from 105 to 123 days. The variation in these characters may be due to the genetic makeup of the genotypes.

Table 1: Mean value of crop phenology related traits of 12 genotypes of chickpea tested at JRP, Itahari, Sunsari in 2018 and 2019 cropping season.

	Days to emergence			Days to 50% flowering			Days to maturity		
Genotypes	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
ICCV-87312	9	9	9	82	85	84	132	143	138
ICCV-98937	9	9	9	90	89	89	133	153	143
ICCV-97207	9	10	9	90	95	93	130	153	142
ICCV-840508-38	9	10	10	87	92	90	129	150	139
ICCV-840508-40	9	9	9	86	92	89	128	150	139
ICCV-840508-41	9	9	9	92	86	89	129	150	140
KWR-108	9	9	9	90	93	92	129	151	140
ICCV-98933	9	9	9	88	87	88	126	151	139
KPG-59	9	9	9	87	91	89	129	146	138
BG-372	9	9	9	86	92	89	132	151	142
ICCV X 840508-31	9	9	9	86	94	90	131	146	139
Tara	9	9	9	89	96	92	135	151	143
Grand Mean	9	9	9	88	91	89	130	150	140
F - Value	NS	NS	NS	**	**	**	**	**	**
LSD (0.05)	-	-	-	3.05	4.8	3.23	1.49	4.03	2.2
C.V (%)	7.2	6.5	5.9	2.1	3.1	2.1	0.7	1.6	0.9

*, Significant at P ≤ 0.05. **, P≤0.01. LSD, least significant difference. CV, coefficient of variance,

Growth Traits

Evaluated genotypes showed significant (P ≤ 0.05) differences in plant height and nodule number while it showed non-significant differences on early plant stand, final plant stand, and branch number (Table 2). Mean performances of genotypes for plant height during the 2018 growing season ranges from 38 to 50 whereas, the mean performance of genotypes tested during the 2019 growing season ranges from 36 to 49 respectively. The mean values of chickpea for plant height ranged from 38 to 47 with pooled mean values of 43. The highest plant height was observed from genotypes KWR-108 (47cm) while the lowest plant height was observed from genotypes Tara (38 cm). Similar results for mean and range for plant height in Chickpea varieties were also reported previously by (Dan et al., 2016, Ejara et. al., 2020 and Ercan et. al., 2013). (Sikdar et.al., 2015) also reported that variation among the varieties in respect of plant height appears due to genotypic variation.

Similarly, the nodule per plant was observed significantly (P ≤ 0.05) differently among the tested genotypes during the two successive growing seasons. Genotypes showed considerable variations in nodule number that ranged from 6 to 13 with the pooled mean performance 9. Six genotypes recorded a superior number of nodules than the mean performance of genotypes (Table 2).

Yield and Yield Components

The variation of genotypes in pods number per plant, seed diameter, hundred seed weight, and seed yield per hectare showed significantly (P ≤ 0.05) different on tests genotypes while it showed a non-significant difference in seed number per pod (Table 3). The mean performance of pod numbers ranges from 10 to 31, 15 to 70, and 16 to 42 during two consecutive growing seasons and pooled mean respectively. Similarly, the variation in seed diameter ranges from 6.4 to 8.6 and 5.4 to 7.6 (mm) during the 2018 and 2019 growing seasons respectively. The pooled mean performance of seed diameter ranges from 5.9 to 8.1. With respect to a hundred seed weight the range ranges from 17.9 to 27.6, 14.7-29.4, and 16.4 to 28.5 (gm) during 2018, 2019, and overall mean respectively. Likewise, the seed yield of the chickpea genotypes ranges from 0.6 to 2.8, 1.5 to 6.9, and 1.2 to 4.4 (ton/ha) respectively during two growing seasons and overall pooled mean. Further, the overall pooled mean performance of genotypes showed the highest number of pods (42), seed diameter (8.1mm), hundred seed weight (28.5 gm), and seed yields (4.4 ton/ha) from genotypes ICCV-840508-38 (42) while the lowest number of pods (16) from genotypes BG-372, seed diameter (5.9mm), hundred seed weight (16.4 gm) from genotypes ICCV-87312, and lowest seed yields (1.2 ton/ha) from genotypes ICCV-840508-41 respectively. The considerable variations in pod number, seed number per plant, and seed per pod were also reported by other authors in Chickpea (Dan, et al. 2016, Ejara et. al. 2020, Ercan, et al. 2013, and Getachew, et al. 2015). (Sikdar et.al., 2015) reported the variation in the number of pods plant –1 was found due to the variation of branch production and also the genetic variations. (Kabir and Sarkar, 2008) reported that the variation in 100 seed weight of the varieties of chickpea might be due to their different genetic characteristics. (Walia et.al., 2019) reported that yields of different chickpea lines/varieties ranged from 157.5 to 425.4 kg ha−1.

Table 2: Mean value of growth related traits of 12 genotypes of chickpea tested at JRP, Itahari, Sunsari in 2018 and 2019 cropping season.

	Early Plant Stand (no.)			Final Plant Stand (no.)			Plant Height (cm)			Branch/plant (no.)			Nodules/plant (no.)		
Genotypes	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
ICCV-87312	157	185	171	157	124	140	40	39	39	3	3	3	7	6	6
ICCV-98937	138	249	194	135	117	126	46	38	42	3	2	3	6	7	6
ICCV-97207	129	147	138	126	99	113	41	49	45	2	3	3	13	13	13
ICCV-840508-38	144	147	145	142	79	111	43	46	44	3	3	3	10	11	11
ICCV-840508-40	152	190	171	149	109	129	45	42	43	3	3	3	7	7	7
ICCV-840508-41	130	137	134	126	64	95	39	41	40	3	3	3	10	9	10
KWR-108	142	163	153	142	103	123	50	44	47	3	3	3	9	9	9
ICCV-98933	131	156	143	131	88	109	45	48	46	3	3	3	8	7	8
KPG-59	146	141	143	146	53	100	41	49	45	3	2	3	13	12	12
BG-372	123	165	144	123	79	101	47	36	42	2	3	3	7	6	6
ICC X 840508-31	133	151	142	132	74	103	44	42	43	3	3	3	10	11	10
Tara	125	167	146	125	92	108	38	38	38	3	3	3	10	10	10
Grand Mean	138	167	152	136	90	113	43	43	43	3	3	3	9	9	9
F-value	NS	NS	NS	NS	NS	*	**	**	**	NS	NS	NS	**	**	**
LSD(0.05)	-	-	-	-	-	26.42	3.86	7.12	4.27	-	-	-	2.95	3.03	2.93
C.V(%)	15.4	24	14.2	15.6	30.6	13.8	5.3	9.9	5.9	14.9	15.6	14.6	19	20.1	19.1

*, Significant at P ≤ 0.05. **, P≤0.01. LSD, least significant difference. CV, coefficient of variance,

Table 3: Mean value of yield and yield components traits of 12 genotypes of chickpea tested at JRP, Itahari, Sunsari in 2018 and 2019 cropping season.

	No. of pod/plant			No. of Seed/pod			Seed diameter (mm)			100 seed Wt. (gm)			Seed Yields (ton/ha)		
Genotypes	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
ICCV-87312	31	47	39	1	1	1	6.4	5.4	5.9	18.2	14.7	16.4	2.1	2.8	2.5
ICCV-98937	18	46	32	1	2	1	7.2	6.1	6.7	17.9	21.7	19.8	1.2	3.2	2.2
ICCV-97207	10	31	20	2	1	1	8.4	7.3	7.9	19.7	21	20.3	1.1	4.7	2.9
ICCV-840508-38	15	70	42	1	1	1	8.6	7.6	8.1	27.6	29.4	28.5	2.8	5.9	4.4
ICCV-840508-40	11	43	27	1	1	1	8.0	6.9	7.4	19.7	22.7	21.2	2.1	2.8	2.5
ICCV-840508-41	17	18	18	1	1	1	6.5	5.5	6.0	20.7	25.3	23.0	0.8	1.5	1.2
KWR-108	22	41	31	2	1	1	7.1	6.1	6.6	19.7	22.0	20.9	1.7	3.0	2.3
ICCV-98933	16	49	32	1	1	1	7.8	6.8	7.3	17.3	23.0	20.1	1.4	6.9	4.2
KPG-59	17	65	41	1	2	1	7.1	6.1	6.6	18.9	25.0	21.9	1.8	6.3	4.0
BG-372	17	15	16	1	1	1	7.1	6.1	6.6	20.6	24.3	22.5	1.0	1.9	1.4
ICC X 840508-31	21	21	21	2	1	1	7.7	6.7	7.2	20.7	21.7	21.2	1.2	2.2	1.7
Tara	15	61	38	2	1	1	7.1	6.1	6.6	19.7	22.3	21.0	0.6	2.8	1.7
Grand Mean	17.4	42.3	29.8	1.4	1.3	1.3	7.4	6.4	6.9	20.0	22.8	21.4	1.5	3.7	2.6
F-value	**	**	**	NS	NS	NS	*	*	*	**	**	**	**	**	**
LSD (0.05)	2.5	16.1	8.5	-	-	-	1.3	1.3	1.3	3.6	3.4	2.2	1.2	1.0	0.9
C.V(%)	8.3	22.5	16.7	16.8	21.9	14.5	10.2	11.9	11.0	10.5	8.9	6.1	20.4	16.0	21.3

*, Significant at P ≤ 0.05. **, P≤0.01. LSD, least significant difference. CV, coefficient of variance,

Biotic stress component

Insect pests and diseases are the major biotic stress factors of chickpea production. Analysis of variance on biotic stress components showed significant ($P \leq 0.05$) differences on test genotypes. Insect pest mainly chickpea pod borer [*Helicoverpa armigera* Hubner) Lepidoptera, Noctuidae] is the main devastating pest of the crops. Pod damage (%) by pod borer was significantly different among the test genotypes (Table 4). The overall mean performance of the two consecutive growing seasons showed that the maximum amount of pest incidence (pod damage) was recorded from genotypes Tara (50.3%) followed by genotypes ICCV-840508-40 (49.4%) and BG-372 (48.2%) respectively and considered as more susceptible genotypes against chickpea pod borer. Similarly, the pest incidence was minimum in genotypes KWR-108 (15.3%) followed by genotypes ICCV-98933 (26.1%) and ICCV-87312 (26.3%) respectively, and considered comparatively less susceptible genotypes against chickpea pod borer. The results of pod damage percentage are in agreement with the results of the authors who stated similar findings, i.e., varieties with more pod borer infestation had more percentage damaged pods and vice versa (Sarwar et al., 2011). (Nadeem et al., 2011) studied ten advanced chickpea genotypes against pod borer and reported that pod damage ranged from 8.2 to 15.8%. (Hossain, 2009) recorded pod damage range from 2.80 to 13.47/plant in 20 different chickpea genotypes and found that the genotype with maximum pod damage was most susceptible. (Parkash et al. 2007) reported 60.1- 94 and 70-95% pod damage by chickpea pod borer respectively. The much variation in pod damage may be due to differences in regional climatic conditions and the tested genotypes.

Fusarium wilt is a major disease of chickpea which causes economic damages to the crops. The overall pooled mean performance of the disease incidence on chickpea ranges from 14.3 to 26.9 % with the mean value of 20.5% respectively (Table 4). The maximum amount of disease incidence was recorded from genotypes ICCV-98937 (26.9%), followed by genotypes KPG-59 (24.8%) and BG-372 (24%) respectively, and considered as more susceptible genotypes against the wilt and blight diseases. Likewise, the minimum amount of disease incidence was recorded from genotypes ICCV-87312 (14.3%), followed by genotypes ICCV-97207 (15.3%) and KWR-108 (15.7%) respectively, and considered as less susceptible genotypes against wilt and blight diseases. Diseases, such as *Fusarium* wilt and *Ascochyta* blight have affected the crop throughout the growing season and at the pod set, respectively. (Anjaneya Reddy, 2002) suggested that complete wilting, plants exhibited turgidity losses and yellowing of leaves in a plant infected with wilt disease. (Ahmad et al., 2010) indicated that some of the cultivar showed resistance reaction at the seedling stage while others showed susceptible reaction at the physiological maturity stage. (Iqbal et al., 2010) were identified five genotypes with genes for tolerance against wilt disease which could be further utilized for developing high yield cultivars with dual tolerance.

Table 4: Mean value of biotic stress component traits of 12 genotypes of chickpea tested at JRP, Itahari, Sunsari in 2018 and 2019 cropping season.

Genotypes	Pest Incidence (%)			Disease Incidence (%)		
	2018	2019	Mean	2018	2019	Mean
ICCV-87312	41.2	11.3	26.3	11.6	16.6	14.3
ICCV-98937	74.6	13.6	44.1	26.4	27.7	26.9
ICCV-97207	64.7	4.3	34.5	12.6	18.8	15.3
ICCV-840508-38	54.1	4.8	29.5	15.8	24.8	19.1
ICCV-840508-40	64.6	34.2	49.4	17.3	23.1	19.9
ICCV-840508-41	36.6	20.2	28.4	18.5	28.8	23.6
KWR-108	23.1	7.4	15.3	13.7	18.5	15.7
ICCV-98933	33.6	18.6	26.1	15.8	22.1	19.0
KPG-59	66.7	15.1	40.9	18.1	32.7	24.8
BG-372	70.1	26.4	48.2	21.1	26.3	24.0
ICC X 840508-31	40.6	35.6	38.1	17.8	26.6	22.3
Tara	70.3	30.4	50.3	18.1	22.7	20.6
Mean	53.35	18.49	35.9	17.2	24.0	20.5
F-value	**	**	**	*	*	**
LSD(0.05)	16.08	12.33	9.58	5.54	7.90	4.05
C.V (%)	16.6	49.4	15.7	19.0	19.6	11.7

*, Significant at $P \leq 0.05$. **, $P \leq 0.01$. LSD, least significant difference. CV, coefficient of variance,

CONCLUSION

The results of this investigation showed significant variation among the genotypes in growth, yields, pest, and disease incidence traits among the genotypes studied. On the basis of the mean performance of yield components and biotic stress components observed in the present study the five genotypes viz., ICCV-840508-38, ICCV-98933, KPG-59, ICCV-87312, and KWR-108 were found to be superior genotypes. Therefore, farmers and chickpea producers around study areas and similar agro-ecologies can use those genotypes for chickpea production as well as these genotypes can be used for further breeding programs too.

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