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Evaluation of yield and yield attributes of seed type cowpea genotypes (*Vigna unguiculata* (*L.*) Walp.) in Mid-Western terai of Nepal

Rajendra Darai[1]*, Padam Poudel[1], NH Ghimire[1] and Man Bahadur Chadaro[1]

[1]*Grain Legumes Research Program Khajuria, Banke, Province 5, Nepal Agricultural Research Council, Nepal*

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***Corresponding author:** Rajendra Darai, Grain Legumes Research Program Khajuria, Banke, Province 5, Nepal Agricultural Research Council, Nepal

Abstract

A total of fourteen seed type cowpea genotypes were evaluated in two consecutive years of 2017 and 2018 to determine their grain yield attributes. The experiment was carried out in randomized complete block design in three replicates at the Grain Legumes Research station. Data were collected on early plant stand, days to flowering, days to maturity, plant height, number of pods per plant, number of seeds per pod, 100 seed weight and grain yield. Collected data were subjected to the analysis of variance using ADEL-R. In 2017, most of the yield and yield attributing traits like days to flowering, days to maturity, grain yield and hundred seed weight recorded significant (P = 0.05) difference due to treatment effects. These genotypes flowered between 49 to 58 days after planting and the maturity period did not exceed 78 days. Cowpea genotypes IT10K-836-2, IT07K-291-92, IT99K316-2, IT10K-973-1 were recorded the highest yielders ranged 1435-2238 kg per hectare than the check Surya. Like in 2018, yield and yield attributing traits like days to maturity, plant height, number of pods per plant, grain yield and hundred seed weight recorded significant (P = 0.05) differences due to the treatment effects. These genotypes flowered between 46 to 56 days after planting and the maturity period did not exceed 83 days. Cowpea genotypes IT07K-299-6, IT82-1337, IT82-889 and IT00K-901-5 were recorded the highest yielders ranged 993-1266 kg per hectare than the check Surya. Pooled mean yield performances over the years indicated that IT10K-836-2, IT07K-291-92, IT07K-299-6 are superior in terms of yield and the possible candidates to promote in the participatory trials. There is need to develop genotypes with the yield attributes and resistance to diseases pests and to suit the needs of different agro – ecological domain can be further tested.

Keywords: Cowpea; Genotypes; Evaluation; Yield; Yield attributes

Abbreviations: GLRP: Grain Legumes Research Program; IITA: International Institute of Tropical Agriculture; EPS: Early Plant Stand; PLH: Plant Height; NPPP: Number of Pods/Plant; NSPP: Number of Seeds/Pod; FPS: Final Plant Stand; LSD: Least Significant Difference

Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is a nutritious summer legume crop that is of considerable importance in Nepal. Ts short-duration summer crop is grown in the rainy (Maize-Cowpea-Vegetables) and spring seasons (Rice-wheat/lentil/chickpea-cowpea). Cowpea constitutes a significant proportion of the total dietary protein and energy intake of Nigerians Davio [1], Ologhbo & Fetuga [2]. The two types of cowpea cultivated in Nepal are grain and vegetable cowpea. Cowpea serve as alternatives or supplements to animal proteins, particularly in parts of the world where there is a paucity of animal proteins due to socio-economic constraints Ojimelukwe [3]. In Nepal, cowpea is primarily used for vegetables, pulses, fodder, and green manures. The grain cowpea is traditionally grown in arid regions, but advances in crop development have allowed it to be grown in other agro-ecological zones throughout the country. This can be accomplished through more efficient crop duration manipulation and a reduction in the severity of pests and diseases. Cowpea is an important component of the farming system due to its ability to restore soil fertility. It contains 23-25% protein, 50–67% starch, 1.3% fat, 1.8% fiber, B vitamins such as folic acid, and essential micronutrients such as iron, calcium, and zinc (Cisse and Hall 2010). It was grown on approximately 11.93 million ha worldwide, yielding 6.22 million tons FAOSTAT [4]. The estimated area, production, and yield of cowpea were 4620.7 ha, 5679.1 metric tons, and 1.23 mt/ha, respectively MOAD [5].

In Nepal, yield evaluation of some cowpea cultivars has continued to generate interest among researchers. Yield evaluation usually involves the consideration of other characters that determine the overall of the genotypes. This is important because yield is a quantitative characteristic and therefore influenced by a num-

ber of traits acting singly or interacting with each other. Earliness, number of branches per plant, pod length, number of seeds per pod, and 1000 seed weight are the necessary agronomic traits of cowpea that contribute to seed yield Ogunbodede [6], Okeleye [7]. Cowpea is adapted to hot weather and requires less rainfall than most crops; as a result, it is grown in semi-arid regions of the lowland tropics and subtropics, where soils are poor and rainfall is scarce Mortimore [8]. Cowpea cultivation is important in developing countries because the crop is drought resistant and performs well in a variety of cropping systems Singh [9]. Farmers in Nepal have grown both indigenous and improved varieties of cowpea in various agro-ecosystems. Till date, only five varieties have been released for grain production. So an experiment is planned to investigate the varietal performance of different genotypes of cowpea in upland conditions in Nepal's western mid hills. The goal of this study is to evaluate the growth, yield attributing characteristics, and yield of cowpea genotypes.

Materials and Methods

Description of Experimental Sites

A field experiment was conducted at Grain Legumes Research Program (GLRP), Khajura, Banke at 810 37" East longitudes and 280 06" North latitude and an altitude of 181 meters above mean sea level for two consecutive cropping seasons (2017 to 2018) in Nepal.

Plant Materials

For this study, 14 cowpea genotypes during 2017 and 2018 including standard check was planted for phenotypic evaluation. Sources of these accessions were mainly originated from International Institute of Tropical Agriculture (IITA), Nigeria. Released Surya was used as a standard check.

Experimental Layout and Design

Present experiment was carried out in Randomized Complete Block Design with three replications. Each experimental plot had six rows with 4.0 m long and 2.4 m wide (9.6 m2) and the central four rows were considered as a net plot area. The distance between plots was 0.50 m. Plants from the internal rows of net plot area were used for data collection and analysis of the parameters under study. The genotypes were planted in the third week of July to August of the years 2017 and 2018. Seeds were dressed by fungicides Bavistin@2.5 g/kg and seed rate was as recommended 60 kg/ha. Recommended agronomic practices were strictly followed for raising a good crop at all the testing sites. Two ploughing was done following by leveling the field. The crop was supplied as recommended dose of fertilizers @20:40:20 Kg NPK per hectare plus 5 ton FYM per hectare during the final land preparation.

Data Collection

Quantitative traits were recorded on 10 randomly selected plants followed by IBPGR Descriptors (Anonymous, 1985). Data was recorded on plant basis for early plant stand(EPS), plant height (PLH cm), number of pods/plant (NPPP), number of seeds/pod (NSPP), final plant stand(FPS), and 100 seed weight (HSWT g) whereas morphological parameters of quantitative data was recorded days to 50% flowering (DF), days to maturity (DM), 100-seed weight in gram (HSWT), and grain yield [GY(kg/ha)]. Grain yield (kgha-1) for the experimental genotypes of each plot was also recorded and all the data of the measured traits were subjected to the statistical analysis.

Statistical Data Analysis

The collected data were subjected to statistical analysis for all the traits and used for the analysis of variance (ANOVA). The estimation of genetic parameters was analyzed using META-R (Multi-Environment Trial Analysis with R) and ADEL-R (Analysis and Design of Experiments with R). Phenotypic variances for the Randomized Complete Design were computed for all traits based on the methods of Federer, 1961. Variations between the treatment means were compared using least significant difference (LSD) at 5% probability level ($p<0.05$). Besides, coefficient of variance (CV%) was calculated to reveal the relative measure of variation that existed within the data. Excel program was used for making bar graph.

Results and Discussion

Table 1 summarizes the effect of varietal differences on early plant stand, number of days to flowering, number of days to maturity, plant height, pods per plant, seeds per pod, final plant stand, seed weight and grain yield. Early plant stand showed a significant ($P = 0.05$) difference. The highest mean of 119 was recorded with IT99K316-2 and IT00K-901-5, followed by 112 with IT11K-61-82. When compared to other varieties, IT010K-827-11 had the lowest early plant stand of 9. The days to 50% flowering statistically differ in all the genotypes. Genotypes IT10k-815-5 and IT07k-243 were the first to flower, at 49 days. 58 longer days to flowering were recorded with IT010K-827-11. This variety flowered in 58 days. While the period between flowering and maturity implies that these varieties must fill their seeds very fast, this is an important trait in areas where water availability is very low. It is worth noting that the number of days to maturity did not exceed 78 days. Another interesting fact about this result is that IT99k316-2 and IT10k-973-1 matured before 66 days, making them more adaptable in drought-prone areas. Similar results were reported by Ndaeyo [10], who found that seed color preference and use differed from region to region and the maturity, growth habit, and photosensitivity requirements depended upon the cropping systems. Furthermore, this result is corroborated by Grema [11] and IITA [12] who found that no single variety of cowpea could be suitable for all conditions. Final plant stand results indicated similar to the early plant stand. A significant ($P=0.05$) difference was observed for all the grain yield components. The result showed that the number of pods per plant ranged from 12 in IT11K-61-82 to 17 in IT10K-836-2. A significant difference was observed in hundred seed weight for all the genotypes, which ranged from 12g

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to 20g for 100 seed weight. Grain yield (kg/ha) was significantly (P = 0.05) superior at 2238 kgha-1 with IT10k-836 followed by IT07k-291-92(1749 kgha-1 and IT99k316-2(1493 kgha-1), although IT010K-827-11 recorded the lowest yield of 1049 kgha-1 in the mean where a significant difference was observed due to genotypes effects.

Table 1: Performance of cowpea (seed) genotypes in CVT at GLRP, Khajura in 2017/018.

SN	Genotypes	EPS	DF	DM	PH(cm)	PP	SP	FPS	GY(Kg/ha)	HSWT(g)
8	IT10K-836-2	34	51	71	51	17	12	31	2238	19.67
13	IT07K-291-92	8	55	77	38	13	10	7	1749	14.67
11	IT99K316-2	119	53	65	49	14	9	100	1493	14.67
7	IT10K-973-1	92	51	66	48	14	10	79	1483	18.67
9	IT82D-889	110	51	68	45	13	11	95	1435	12.33
10	IT82-1337	77	54	68	39	14	10	72	1385	16.67
14	Surya	101	51	65	52	14	10	96	1317	14.67
2	IT08K-150-12	94	52	72	49	13	9	85	1292	18
4	IT11K-61-82	112	55	70	50	12	12	93	1291	14
1	IT10K-815-5	90	49	69	37	13	9	89	1246	17.67
12	IT00K-901-5]	119	54	68	47	16	12	102	1243	12
5	IT07K-299-6	93	54	78	42	17	10	70	1234	16
6	IT07K-243	81	49	71	42	14	8	76	1214	17
3	IT010K-827-11	9	58	74	42	15	11	7	1049	16
	Mean	**85**	**53**	**70**	**45**	**14**	**10**	**75**	**1341**	**15.56**
	P-value	**<0.01**	**0**	**<0.01**	**0.29**	**0.64**	**0.15**	**<0.01**	**0.01**	**<0.01**
	CV%	**20.5**	**5**	**1.64**	**16.75**	**21.5**	**16.3**	**17.4**	**21.51**	**13.55**
	LSD (0.05)	**28**	**4.4**	**1.93**	**12.69**	**5.18**	**2.86**	**20.9**	**507.07**	**3.61**

Table 2: Performance of cowpea (seed) genotypes in CVT at GLRP, Khajura in 2018/019.

SN	Genotypes	EPS	DF	DM	PLH(cm)	NPPP	NSPP	FPS	GY(kg/ha)	HSWT(g)
1	IT10K-815-5	113	48	71	47	9	6	77	622	21.67
2	IT08K-150-12	113	54	83	87	8	9	88	890	22.33
3	IT010K-827-11	115	56	79	39	9	9	71	711	21
4	IT11K-61-82	114	48	79	50	10	10	85	872	18.33
5	IT07K-299-6	108	49	79	45	12	9	94	1266	21
6	IT07K-243	118	46	75	39	7	7	83	753	22
7	IT10K-973-1	100	47	81	43	6	8	67	809	24
8	IT10K-836-2	114	51	78	51	7	8	85	660	21
9	IT82D-889	133	52	74	45	8	9	104	998	17.33
10	IT82-1337	102	54	80	43	11	9	75	1007	20.67
11	IT99K316-2	122	48	65	51	10	8	103	892	18.33
12	IT00K-901-5]	115	49	80	46	9	9	100	992	16.33
13	IT07K-291-92	104	48	83	59	7	9	76	882	22
14	SURYA	103	49	75	52	11	8	93	907	18
	Mean	**112.3**	**50**	**77.3**	**49.76**	**8.9**	**8.39**	**85.8**	**875.86**	**20.29**
	P-value	**0.82**	**0.1**	**0.02**	**<0.01****	**0**	**0.23**	**0.22**	**<0.01****	**<0.01****
	CV%	**17.31**	**8.5**	**6.7**	**11.46**	**23**	**16.5**	**20**	**11.82**	**6.69**
	LSD	**32.64**	**7.1**	**8.69**	**9.57**	**3.4**	**2.37**	**28.8**	**173.81**	**2.28**

The result showed bolder seeded cowpea genotypes IT10k836-2, IT08k-150-12 and IT10k-973-1 with more than 18 g per hundred seed weight. The effect of varietal differences on yield and yield-attributing traits is also summarized in Table 2. Statistically significant differences were observed in the phenotypic traits days to maturity, plant height, number of pods per

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plant, grain yield and hundred seed weight. Research results revealed the number of days to maturity was not greater than 83 in genotypes IT08K-150-12 and IT07K-291-92 while IT99K316-2 matured earlier in 65 days might be more adaptable for drought-prone areas. Plant height showed the highly significant differences and maximum plant height was recorded in the genotype IT08K-150-12(87 cm) while lowest plant height was recorded in IT010K-827-11 and IT07K-243(39 cm). The result showed that the number of pods per plant was significantly differed and highest number of pods per plant was recorded in the genotypes IT07K-299-6, IT82-1337 and surya. Grain yield (kg/ha) was significantly (P = 0.05) superior at 1200 kgha-1 with IT07K-299-6 followed by IT82-1337 (1007 kgha-1) and IT82D-889 (998 kgha-1) than the check Surya (907 kgha-1), although IT10K-815-5 recorded the lowest yield of 622 kgha-1 in the mean where a significant difference was observed due to genotypes effects. A significant difference was observed in hundred seed weight for all the genotypes, which ranged from 17g to 24g for 100 seed weight. The result showed bolder seeded cowpea genotypes IT10K-973-1 and IT08K-150-12 with more than 22 g per hundred seed weight.

Table 3: Mean performances of cowpea (seed type) genotypes in CVT over the years 2017-2018.

SN	Genotypes	DF	DM	PLH(cm)	GY(Kg/ha)	HSWT(g)
1	IT10K-815-5	48	70	42	934	19.67
2	IT08K-150-12	53	77	68	1091	20.17
3	IT010K-827-11	57	76	41	880	18.5
4	IT11K-61-82	52	74	50	1082	16.17
5	**IT07K-299-6**	**52**	**79**	**43**	**1250**	**18.5**
6	IT07K-243	47	73	40	984	19.5
7	IT10K-973-1	49	73	46	1146	21.33
8	**IT10K-836-2**	**51**	**75**	**51**	**1449**	**20.33**
9	IT82D-889	52	71	45	1217	14.83
10	IT82-1337	54	74	41	1196	18.67
11	IT99K316-2	50	65	50	1192	16.5
12	IT00K-901-5]	52	74	47	1118	14.17
13	IT07K-291-92	51	80	49	1316	18.33
14	SURYA	50	70	52	1112	16.33
	Residual Variance	**12.5**	**14.1**	**44.8**	**51002.29**	**3.1**
	Grand Mean(N=14)	**51.3**	**73.7**	**47.5**	**1140.32**	**18.07**
	LSD	**4.45**	**7.16**	**17.8**	**561.47**	**2.2**
	CV%	**6.89**	**5.09**	**14.1**	**19.8**	**9.74**
	Genotype significance	**0**	**0**	**0.13**	**0.01**	**0**
	Gen x Year significance	**0.96**	**0.04**	**0**	**0**	**1**

The combined analysis of variance (ANOVA) indicated genotypic differences in days to flowering, days to maturity, grain yield, and hundred seed weight, while the interaction effect of GxY over the years significantly differed in the traits days to maturity, plant height, and grain yield only. Pooled mean analysis showed genotypes such as IT07K-243 and IT10K-815-5 were found to be earlier flowering, whereas genotypes such as IT010K-827-11 and IT82-1337 were found to be late flowering. Flowering days ranged from 47 to 57, which was higher than previous researcher findings. Yohana [13] reported that the time taken for flowering varied from 50.67 to 70.17 days under Nigerian conditions. Likely, there was a significant difference in maturity days among the characters. Research results indicated the range of maturity was from 70 days in IT10K-815-5 to 80 days in IT07K-291-92, with a mean of 74 days. Plant height showed highly significant differences, with the genotype IT08K-150-12 having the highest plant height (68 cm) and the genotype IT07K-243 having the lowest plant height (40 cm). El-Nahrawy [14] also reported significant differences in plant height for 24 cowpea genotypes. There is a highly significant difference in 100 seed weight between all genotypes. Genotypes like IT10K-973-1, IT10K-836-2, IT08K-150-12 had a higher seed weight (20–21 g) than a standard check. The average weight of 100 seeds was 18.07. Musvosvi [15] reported highly significant differences in genotypes for number of days to 50% flowering, number of days to first 50% mature pods, pod length, and weight of 100 seeds, which is consistent with our findings, which were higher than those reported by Idahosa [16] who found hundred-seed weight ranged from 8.97 to 13.40g in Nigeria for eight cowpea genotypes. Grain yield ranges from 934 to 1449 kg/ha-1 with mean yield of 1140 kg ha-1Grain yield (kg/ha) was significantly (P = 0.05) superior at 1449 kgha-1 with IT10K-836-2 followed by IT07K-291-92 (1316 kgha-1) and IT07K-299-6 (1250 kgha-1) than the check Surya (1112 kgha-1)., although IT10K-815-5 recorded the lowest yield of 934 kgha-1in the mean,

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where a significant difference was observed due to the genotypic effects. Gerrano [17] reported significant differences among genotypes for grain yield

Discussion

This result showed that where there were more pods per plant, the highest plant height, and more seed weight, the yield increased. Based on the results of the present study, the cowpea yield in Nepal is low. The use of early-maturing varieties as adopted in this study can help minimize these problems. This study supports the earlier findings of Ofori & Djagbletey [18], Okeleye et al. 2001 who reported that early maturing cowpea genotypes yield as much as or more than late maturing varieties, with the added benefit of being suitable in areas with unreliable rainfall in terms of total amount, distribution, and duration, where crop failure is frequently attributed to the early cessation of rains. This makes it adaptive to different agro-ecological environments in Nepal. Varietal requirements in terms of plant type, seed type, maturity, and yield for cowpea vary in different agro-ecologies, thus the importance of the selection of varieties. Musvasvi [15], Khan [19], Garrano [17], and Idahosa [16] also reported significant differences for all the characters studied except plant height of cowpea genotypes, which means that these characteristics can be improved by selection in breeding programs. Gerrano [17] reported pods per plant ranging from 10-3. The availability of genetic variability on these studied traits caused significant differences among genotypes, which provides an opportunity to improve the existing germplasms for targeted traits and environments. The higher yield of the above varieties might be due to the moderately higher number of pods per plant, pod length, and individual pod weight. Various scientists, including Rajput [20], Neema [21], and Pandey [22], observed variation in yield between varieties [23,24,25].

Conclusion

It can be concluded from a two-year study that cowpea genotypes IT10K-836-2, IT07K-291-92, and IT07K-299-6 recorded the highest yields of 1250 kg ha-1 to 1449 kgha-1 [26] and therefore can be recommended to farmers and will need to be promoted in the participatory trial [27,28]. Cowpea genotype IT99K316-2 was of earlier maturity, while genotypes IT10K-973-1, IT10K-836-2, and IT08K-150-12 had bold seeded genotypes.

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