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Performance Evaluation of Cowpea *(Vigna unguiculata L.)* Varieties Under Moisture Conservation Practices for Yield and Yield Components at Alduba, Southern Ethiopia

Tekle Yoseph
Crop Science Research Case Team, Southern Agricultural Research Institute
Jinka Agricultural Research Center, Jinka, Ethiopia

Abstract
A field experiment was conducted at Alduba, Southern Ethiopia to determine the effect of moisture conservation practices and varieties on yield and yield components of cowpea (Vigna unguiculata L.) under rain fed condition in 2013. The experiment was conducted with two levels of moisture conservation practices (farmers practice and tied ridge), eight cowpea varieties (Black-eye bean, Bole, Maze-1, Asrat, Bekur, Assebot, IT-99k-1122 and White-wonder-trail). The experimental design was a split plot with three replications where, moisture conservation practice was arranged as main plot factor and cowpea varieties were arranged as sub plot factors, respectively. Phenological and growth parameters such as yield and yield components, total biomass and harvest index were studied. The result showed that all phenological and growth parameters were not significantly affected by moisture conservation practices. The number of days required to reach at mid flowering, pod setting and maturity were delayed when tied ridge was used. Use of tied ridge increased all the studied phenological parameters except number of branches per plant. Yield and yield components were not significantly affected by moisture conservation practices. Even though, moisture conservation practices did not bring significant effect on grain yield, but yield advantage of tied ridge was 26% over farmers practice in this study. There were significant variations observed among the cowpea varieties for all the phenological and growth parameters under study. There were significant variations observed among the cowpea varieties for all the yield and yield components in the study. The maximum grain yields (12.94 qt ha^{-1}) and (12.44 qt ha^{-1}) were recorded from the varieties IT-99K-1122 and Assebot, respectively. There was no significant interaction between moisture conservation practices and varieties for all the studied parameters except grain yield. Therefore, it can be concluded from this result that use of tied ridge or the best performing varieties of cowpea namely, IT-99K-1122 or Assebot is advisable and could be appropriate for cowpea production in the test area even though further testing is required to put the recommendation on a strong basis.
Keywords: Tied ridge, Varieties, Farmers Practice

1. Introduction

Cowpea (*Vigna unguiculata L*) is an annual legume and an important source of proteins (up to 35%) for food and can therefore validly replace animal protein in the world where plant production is by far more important than animal production [1]. Among grain legumes, cowpea (*Vigna unguiculata L.*) is the most cultivated and the most consumed especially in Asia and in tropical Africa [2]. In addition to its importance in human food, cowpea is also useful for soil fertilization through symbiotic nitrogen fixation [4]. Cowpea (Vigna unguiculata L.) is an annual legume and is an important crop as source of protein [5 and 6]. The seed of cowpea is used as food for human being as well as animals. The biomass of cowpea is also used as the source of fodder for livestock. It is domesticated along with sorghum and pearl millet in Ethiopia due to the close association with this crop in early African farming [3]. Drought has major implications for global food supply because of the expected effects gradual climatic change and the variations in climatic in short term that it is to bring [7]. It is generally considered that use of drought tolerant crop varieties with effective soil moisture conservation practices is an important for improved crop production in an advanced manner.

Cowpea is an excellent drought tolerant crop; therefore, it can be produced in drought prone areas of Sothern Ethiopia. However, its production is threatened by declining yield potential of the existing local cultivars with poor agronomic management, disease and pest as a production constraint to this crop. There is trend of cowpea production in some localities of Southern Ethiopia, such as Konso areas and some parts of South Omo zone, since these zones are endowed with good potential for cowpea production. In these areas, there is also problem of soil moisture availability. In order to improve crop production in the study areas, use of moisture conservation practices to escape the prevailing drought in the target areas is crucial. Therefore, to meet the domestic needs, the increasing demand of the crop by the farmers and finding the suitable solution for the major production constraints, introduction of improved cowpea varieties with improved agronomic management options that can increase grain and biomass yield of the cowpea by improving the soil moisture status is of a vital key. Hence, this research was initiated with the objective of selecting the best performing and high yielding cowpea varieties with improved moisture conservation practices in the study areas.

2. Materials and Methods

2.1. The Treatments, The Study Area and Experimental Design

Field experiment was conducted at Alduba research field in Bena Tsemay woreda of Southern Ethiopia in 2013. Alduba is located about 720 kms from South of Addis Ababa. Geographically, Alduba is found at E 36^0 36' 30.8" Longitude and N 05^0 25' 00" Latitude and at an altitude of 1343 meters above sea level. The experiment was executed at Alduba in a split plot design with three replications during the 2013 cropping season under rain fed condition. The treatments involved were eight improved varieties of cow pea (Black-eye bean, Bole, Maze-1, Asrat, Bekur, Assebot, IT-99k-1122 and White-wonder-trail) under two moisture conservation practices (tied ridge and farmers practices).

2.2. Data collection

Phenological Parameters and Growth Parameters

Phenological parameters such as days to flowering, days to pod setting and days to maturity were recorded. Days to flowering and days to pod setting were recorded by counting the number of days after emergence when 50 % of the plants per plot had the first open flower and form pod, respectively. Days to maturity was recorded when 90% of pods matured per plot. At mid flowering stages five plants from each of the plots were selected randomly and uprooted carefully to determine crop growth parameters such as plant height.

Grain Yield, Yield Components, Total Biomass and Harvest Index

Three central rows were harvested for determination of grain yield. Grain yield was adjusted to 12.5% moisture content. Five plants were randomly selected from the three central rows to determine yield and yield components, which consisted of number of pods per plant, number of seeds per pod and thousand seeds weight. Pod number per plant was determined by counting pods of the five randomly selected plants while number of seeds per pod was recorded by counting the total number of seeds in a pod from ten randomly sampled pods taken from the five randomly selected plants. Seed weight was determined by taking a random sample of 1000 seeds and adjusted them to 12.5% moisture content. Total biomass yield was measured from the three middle rows when the plant reached harvest maturity. Harvest index was calculated as the ratio of seed yield to total above ground biomass yield.

2.3. Statistical Analysis

All the agronomic data were recorded and being subjected to analysis [8]. Analysis of variance was performed using the GLM procedure of SAS Statistical Software [8]. Effects were considered significant in all statistical calculations if the P-values were ≤ 0.05. Means were separated using Fisher's Least Significant Difference (LSD) test.

3. Results and Discussion

The analysis of variance result depicted that moisture conservation practices did not bring significant effect on days to flowering, days to pod setting, days to maturity, plant height, number of branches plant^{-1} and pod length (Table 1). On the other hand, days to flowering, days to pod setting and number of branches plant^{-1} were significantly ($P \leq 0.05$) affected due to varieties and days to pod setting, plant height and pod length were highly significantly ($P \leq 0.001$) affected by varieties (Table 1).This indicates that there exists linear response of the studied phenological and growth parameters to varieties. In this experiment, all the phenological and growth parameters were significantly affected by varieties (Table 1). The highest and the least plant heights of 34.97 cm and 20.00 cm were recorded for the varieties White Wonder trail and Asrat, respectively, the maximum and minimum number of branches plant^{-1} were noted for the varieties Bole and Asrat, respectively, and the highest and the least pod lengths of 18.39 cm and 12.25 cm were recorded for the varieties IT-99K-1122 and Maze-1, respectively (Table 2).

Table 1: Mean Square Values for Crop Phenology and Growth Parameters as Influenced by Moisture Conservation practices and Varieties at Alduba, in 2013.

Source	DF	Days to flowering	Days to pod setting	Days to maturity	Plant height (cm)	Branch number (plant^{-1})	Pod length (cm)
Replication (R)	2	2.13ns	0.89^{ns}	121.93^{ns}	8.58^{ns}	1.97^{ns}	0.79^{ns}
Moisture Con (MC)	1	0.02ns	1.33ns	3.00ns	19.76^{ns}	0.9ns	0.02ns
Error a	2	3.80	2.80	30.43	1.82	0.38	2.19
Variety (Var.)	7	52.21*	60.06*	82.78***	139.73***	8.15*	22.15***
Var * MC	7	7.24^{ns}	8.17^{ns}	12.98ns	6.79^{ns}	0.52^{ns}	4.07ns
Error b	28	15.28	17.37	24.95	38.05	2.37	6.77

*, ** and *** indicate significance at P< 0.05, P< 0.01 and P< 0.001, respectively and 'ns' indicate non significant

Table 2: Crop Phenology and Growth Parameters of Cowpea as Affected by Moisture Conservation Practices and Variety at Alduba, in 2013.

Treatments	Days to flowering	Days to pod setting	Days to Maturity	Plant height (cm)	Number of branches	Pod length (cm)
Moisture Con (MC)						
Flat Land	54.70a	71.75a	93.37a	23.45a	6.96a	14.03a
Tied Ridge	54.66a	72.08a	93.87a	24.74a	6.69a	14.08a
LSD 0.05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV%	**3.56**	**2.37**	**5.89**	**5.9**	**9.03**	**10.52**
Variety (Var.)						
BLACK EYE BEAN	57.00ab	75.00ab	98.16ab	27.77a	7.50ab	13.34c
BOLE	52.66bc	69.66bcd	92.00cd	21.46c	8.00a	12.59c
MAZE-1	56.83ab	73.83abc	95.66bc	25.66b	7.40ab	12.25c
ASRAT	53.16bc	70.50bcd	91.00cd	20.00c	5.00c	13.58c
BEKUR	53.33bc	70.33bcd	89.66d	20.20c	5.57bc	12.33c
WHITE WONDER	61.33a	78.83a	101.67a	34.97a	6.66bc	16.86b
IT-99K-1122	52.16bc	69.16dc	91.00cd	20.80c	7.93ab	18.39a
ASSEBOT	51.00c	68.00d	89.83d	21.93c	6.26bc	13.90c
LSD 0.05	**4.91**	**4.87**	**4.4**	**3.54**	**1.89**	**1.93**
CV%	**7.14**	**5.79**	**5.33**	**5.03**	**9.51**	**4.3**

Note: Means with the same letters within the columns are not significantly different at P <0.05.

The analysis of variance result revealed that moisture conservation practices did not bring significant effect on grain yield, number of pods plant^{-1}, number of seeds pod^{-1}, 1000 seeds weight, total biomass weight and harvest index (Table 3). Though non significant effect was observed due to moisture conservation practices in this study, accordingly tied ridge stands exhibited about 26% yield advantages over farmers' practices. Similar yield advantage on coffee was observed under tied ridge than flat land [9]. It was also reported that there was yield advantage for annual crops under closed ridges over flat plot stands [10]. The increase in cowpea grain yield under tied ridge may be attributed to the efficient utilization of the retained soil moisture conserved by the ridge during the rainfall period. In this study, it was observed that yield advantage was noted under tied ridge over the farmers' practices for all the cowpea varieties. Tied ridge gave consistently higher grain yield for all the cowpea varieties Bole, Asrat, Bekur, White wonder trail, IT-99k-1122 and Assebot except for Black-eye bean and Maze-1. Grain yield and number of seeds pod^{-1} were highly significantly ($P \leq 0.001$) affected due to varieties. Number of pods plant^{-1} and 1000 seeds weight were significantly ($P \leq 0.01$) affected by varieties and total biomass weight and harvest index were significantly ($P \leq 0.05$) affected by varieties (Table 3). This indicates that yield and yield components were highly influenced by varieties. Generally in this experiment, all the yield and yield components studied were significantly affected by varieties (Table 3). The highest grain yield of 12.94 qt ha-1 was recorded for the variety IT-99K-1122 (Table 4). The least grain yield of 5.87 qt ha^{-1} was recorded for the variety Black-eye bean. The same finding was recorded on the variety Black eye bean [11]. The maximum and minimum number of pods plant^{-1} of 17.83 and 8.61 were noted for the varieties IT-99K-1122 and Maze-1, respectively. The highest number of seeds plant^{-1} of 10 was recorded for the variety Assebot; on the other hand, the minimum number of seeds plant^{-1} of 4 was noted for the variety Black-eye bean. Similar result was observed on the variety Black eye bean [11]. The maximum and the minimum 1000 seeds weights of 28.80 gm and 19.30 gm, respectively were recorded for the varieties White Wonder trail and Bole, respectively, the maximum and the minimum biomass weights of 23.41 qt ha^{-1} and 11.5 qt ha^{-1} were noted for the varieties Assebot and Bekur, respectively and the highest and the least harvest index of 0.73 and 0.28 were recorded for the varieties Bekur and Asrat, respectively (Table 4). This showed that grain yield attributing parameters were influenced by varieties.

Table 3: Mean Square Values for Yield and Yield Components, Total Biomass and Harvest Index in Cowpea at Alduba, in 2013.

Source	DF	Grain yield (t ha^{-1})	Pods plant^{-1}	Seeds pod^{-1}	1000 seeds wt(gm)	Total biomass (t ha^{-1})	Harvest index
Replication (R)	2	1.09ns	29.39^{ns}	12.87**	80.56**	30.26^{ns}	0.o5^{ns}
Moisture Con (MC)	1	0.84ns	5.33ns	0.18ns	15.18^{ns}	9.80ns	0.005ns
Error a	2	10.85	74.22	2.55	8.31	11.65	0.02
Variety (Var.)	7	34.18***	49.61**	24.17***	42.46**	131.30*	0.11*
MC*Var	7	26.07**	6.98^{ns}	1.90ns	6.81^{ns}	44.19^{ns}	0.02ns
Error b	28	14.94	21.74	7.62	5.47	46.53	0.04

*, ** and *** indicate significance at P< 0.05, P< 0.01 and P< 0.001, respectively and 'ns' indicate non significant

Table 4: Yield and Yield Components of Cowpea as Affected by Moisture Conservation Practices and Varieties at Alduba, in 2013.

Treatments	Grain yield (qt ha^{-1})	Pods plant^{-1}	Seeds pod^{-1} (gm)	1000 seeds	Total biomass (qt ha^{-1})	Harvest Index
Moisture Con (MC)						
Flat Land	9.92a	13.58a	6.83a	12.49a	17.53a	0.54a
Tied Ridge	10.18a	14.25a	6.95a	12.61a	18.43a	0.56a
LSD 0.05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV%	**5.72**	**9.25**	**23.17**	**12.5**	**18.98**	**25.71**
Variety (Var.)						
BLACK EYE BEAN	5.87d	12.66c	4.00d	25.73ab	10.82c	0.49ab
BOLE	10.25abc	18.50a	4.33d	19.30d	16.94abc	0.49ab
MAZE-1	9.12c	8.16d	6.33d	24.66abc	16.11abc	0.56a
ASRAT	9.20bc	13.00c	6.16c	23.00bcd	23.11a	0.28b
BEKUR	8.92c	13.83c	8.66ab	20.20d	11.50bc	0.73a
WHITE WONDER	11.63abc	14.50bc	7.33bc	28.80a	21.30a	0.61a
IT-99K-1122	12.94a	17.83ab	8.33ab	20.80cd	20.64ab	0.68a
ASSEBOT	12.44ab	12.83c	10.00a	21.93bcd	23.41a	0.59a
LSD 0.05	**2.86**	**3.58**	**1.72**	**3.83**	**8.41**	**0.20**
CV%	**6.20**	**5.78**	**21.91**	**10.14**	**6.15**	**6.03**

Note: Means with the same letters within the columns are not significantly different at P <0.05.

4. Conclusion and Recommendation

Eight cowpea (Vigna unguiculata L.) varieties were evaluated under two moisture conservation practices at Alduba under rain fed conditions in 2013. The objectives of the study were to select the best performing cowpea varieties, effective moisture conservation practices that will improve cowpea production. The experiment was carried out using the split plot design with three replications at Alduba in 2013. The treatments involved were eight improved varieties of cow pea (Black-eye bean, Bole, Maze-1, Asrat, Bekur, Assebot, IT-99k-1122 and White-wonder-trail) under two moisture conservation practices (tied ridge and farmers practices). Even though, tied ridge had not brought significant effect on the studied parameters for cowpea in this study; but yield advantage of tied ridge was 26% over farmers practice was recorded in this study. Therefore; it is better to use tide ridge to enhance cowpea production in the study area. There were significant variations observed among the cowpea varieties for all the phenological and growth parameters in this study. There were also significant variations observed among the cowpea varieties for all the yield and yield components. The effects of varieties on all yield and yield components were significant and the best performing varieties of cowpea namely IT-99K-1122 (12.94 qt ha^{-1}) and Assebot (12.44 qt ha^{-1}) would be recommended for further production in the studied area and its vicinity. Further study should be carried out with tied ridge to improve cowpea production with increased yield and biomass production.

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