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Adaptation Trial of Cowpea (*Vigna unguiculata L.*) Varieties in Lowland Land Areas of Buno Bedele Zone, South Western Oromia

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Abstract

The experiment was conducted at three sites in selected districts of Gechi, Bedele and Dabo-Hana during the main cropping season of 2021 and 2022. The objectives of the experiment were to evaluate and select the best adaptable and high dry matter yielder of cowpea varieties for the study areas. Seven cowpea varieties were evaluated using Randomized Complete Block Design (RCBD) with three replications. Data on plant height, maturity date, disease, dry matter (DM) and seed yield were collected and analyzed. The result revealed that varieties had responded differently ($P<0.05$) in plant height, disease, maturity date, dry matter and seed yield. The highest dry matter yield was recorded from Adulala (13.91t/ha) followed by Temesgen (12.14t/ha) varieties while the least (7.51t/ha) DM yield was obtained from Black eyed variety. The result also indicated that the maximum (32.65qt/ha) seed yield was recorded by Kenkety followed by Temesgen (29.55Qt/ha) and Adulala (26.82Qt/ha) varieties at Gechi in 2021 cropping season. The occurrences of disease and pests on these varieties were also very low as compared to the other varieties. Moreover, analysis of result of the dry matter yield using the comparison GGE Bi-plot shows that Adulala, Bole and Temesgen varieties were the most stable and desired varieties as compared to the other varieties. Based on the agronomic, biomass and seed yield as well as stability test; Adulala, Bole, and Temesgen varieties had showed the best performance as compared to the other varieties. Therefore, Adulala, Bole, and Temesgen cowpea varieties were recommended for further demonstration and scaled-up for the study areas and similar agro-ecologies.

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Keywords

Adulala, Bole, Cowpea, Dry matter yield, Temesgen, Varieties

Introduction

Introduction Cowpea (*Vigna unguiculata* L.) is an essential crop in developing countries of Africa where it is consumed as dry seeds, fresh green pods or leaves (Badiane *et al.,* 2004). Cowpea is a warm-season, annual, herbaceous legume crop well adapted to many areas of the humid tropics and temperate zones. It tolerates heat and dry conditions, but is intolerant of frost (Davis *et al.,* 1991). Cowpea crop is grown as a green manure and also a cover crop to increase soil fertility, retain moisture and reduce soil erosion (Koralagama *et al.,* 2002). These plant types are often categorized as erect, semi-erect, prostrate (trailing), or climbing. Cowpea forage is usually superior to other forage legumes in terms of both quantity and quality. Because of its high proteins, vitamins and minerals contain, cowpea plays an important role in human consumption and animal feeding (Singh *et al.,* 1997; Nielsen *et al.,* 1997). It is an excellent quality crop for fattening both sheep and cattle, and is also regarded as good feed for milking cows. Cowpea can significantly improve soil nitrogen levels by

nitrogen fixation or by incorporation in the soil as a green manure crop. Cowpea residue is an important fodder resource for ruminant livestock (Tarawali *et al.,* 1997). The stovers from cereals have low nitrogen and high fibre contents and poor digestibility, and therefore have low nutritive value, while the stover from legumes are of high nutritional quality (Singh *et al.,* 2004). Especially, leaves of legume crops can provide good quality forage materials.

The potential to improve livestock productivity on available feed resources (native pasture, crop residues and agro industrial by- products) is limited due to different reasons like poor nutritive values of native pasture and crop residues and high cost and limited availability of agro industrial by- products. So to alleviate this problem we need to look for other options. Huge opportunity is created to fill the gap of feed shortage with the use of numerous promising improved forage crop species identified for various agro-ecologies, with particular emphasis on cultivated forage crops. But, the adoption rate for improved forage crops has been very low and less sustainable. In mixed crop-livestock production systems of Buno Bedele Zone, livestock mainly dependent on natural pasture which they can‘t provide high production and productivity beyond maintenance.

Hence, integration of cowpea with mixed crop-livestock farming activity can be important in improving feed quality, soil fertility and livestock production and productivity in the study areas where the livestock production activity is prioritized. Therefore, the objective of the study was to evaluate and select the best adaptable and high dry matter yielders of cowpea varieties in the lowland areas of Buno Bedele Zone.

Materials and Methods

Experimental materials and design

The experiment was conducted during 2021 and 2022 main cropping season in selected districts of Bedele (Cilalo Bildima FTC), Gechi (Chara FTC) and Dabo Hana (Dahe sub site) of Buno Bedele Zone, South Western Oromia. The experiment consisted of seven cowpea varieties namely: Bole, Temesgen, Adulala, Kenkety, Assebot, Black eyed and White wonder. The experiment was laid out in randomized block design with three replications. All the treatments were randomly allocated to different plots in each replication. A plot size of 3 m x 1.8 m was used. The spacing between plants, rows and blocks were 20 cm, 30 cm and 1 m, respectively. Seed rate of 30kg/ha was used while NPS fertilizer at a rate of 100 kg/ha was applied during sowing. Weeds were also removed from all plots before flowering; depend on rate of growth of the weeds and their density.

Data collection and analysis

All relevant agronomic and yield data including plant height, dry matter yield, disease (1-5score), maturity date and seed yield were collected. Five plants were randomly selected from each plot and plant height was measured from the base of the plant to the flag leaf. The mean plant height was then calculated. Forage biomass yield was estimated by harvesting the forage at 50% flowering stage at a height of 5 cm near the ground. Plants in the middle row of the plots were harvested and weighed immediately to obtain fresh yield. The harvested forage samples were manually chopped into small pieces using sickle and a sub-sample of 300 gm fresh weight were taken and oven dried for determination of herbage dry matter yield. Forage DM yield (t/ha) was obtained by using James *et al.,* (2008) formula which is DM yield (t/ha) = (10 x TFW x SSDW)/ (HA x SSFW).

Where; 10 = constant for conversion of yields in kg/m2 to tone/ ha, TFW = total fresh weight from harvesting area (kg), SSDW = sub-sample dry weight (g), SSFW= sub-sample fresh weight (g). The recorded data were analyzed using the Gen stat software version 18.1and significant means separated by using least significance difference (LSD) at 5% probability level.

Results and Discussion

Analysis of variances

The analysis result of mean square variance of the tested cowpea varieties were shown in table 1. The result shows that varieties of cowpea were significantly ($p<0.01$) different in plant height, dry matter yield, maturity date and seed yields. The effect of locations reveals a significant ($p<0.01$) difference in dry matter yield, maturity date and seed yields whereas a variation of year was influenced significantly all parameters except seed yield. The interaction of variety by location didn‘t showed a significant effect on all tested parameters. On the other hands, varieties with location and year interaction has a significant ($p<0.05$) effect on seed yield while the interaction didn‘t significantly ($p>0.05$) affected the other parameters.

Plant height

The analysis result of plant height of the tested varieties was indicated in the table 2. The combined mean result showed a significant ($p<0.05$) variation among all varieties in plant height. Adulala variety showed the highest plant height (179.1 cm) followed by White wonder variety (161.9 cm) while the lowest plant height (133.4 cm) was recorded by Assebot variety. The differences among varieties in plant height might be due to the differences in genetic makeup (Gebremedhn Beyene *et al.,* 2015).

Dry matter yield

The result of combined analysis showed that dry matter yield was significantly ($p<0.05$) different among the cowpea varieties (Table 2). Among the tested cowpea varieties, Adulala, Bole and Temesgen were produced the maximum dry matter yield of 13.91 t/ha, 12.49 t/ha and 12.14 t/ha respectively. Black eyed variety was produced the lower (7.51t/ha) dry matter yield. The mean biomass yield recorded for cowpea varieties in the current study is better than the values (4.4- 8.37 t/ha) reported by other scholars (Gebreyowhans and Gebremeskel 2014, Ayana *et al.,* 2013). These variations may be due to the differences in genetic potential and adaptability of the varieties. Other studies also indicated that the difference between cowpea varieties could be due to their morph physiological characteristic (Vincent *et al.,* 2021).

Maturity date

The analysis result for seed maturity date of cowpea varieties was presented in (table 2). Significance ($P<0.05$) variation among the tested cowpea varieties was observed in maturity date. The longest (108.4) maturity date was recorded for Temesgen varieties followed by Black eyed (108.3) and Adulala (107.3), while the shortest date (94.3) of maturity was recorded for Kenkety variety.

Seed yield

There was significant ($p<0.05$) variation recorded for seed yield among all varieties of cowpea (Table 3). The result indicated that the highest mean (22.7qt/ha) seed yield was recorded at Gechi district in the year of 2022 while the lowest (9.8qt/ha) mean seed yield was recorded in 2021 at Bedele site. It is also revealed that that the maximum (32.65qt/ha) seed yield was recorded by Kenkety followed by Temesgen (29.55qt/ha) and Adulala (26.82qt/ha) varieties at Gechi in 2021.

Fig.1 GGE Biplot analysis of Dry matter yield (t/ha) at Bedele, Gechi and Dabo Hana districts

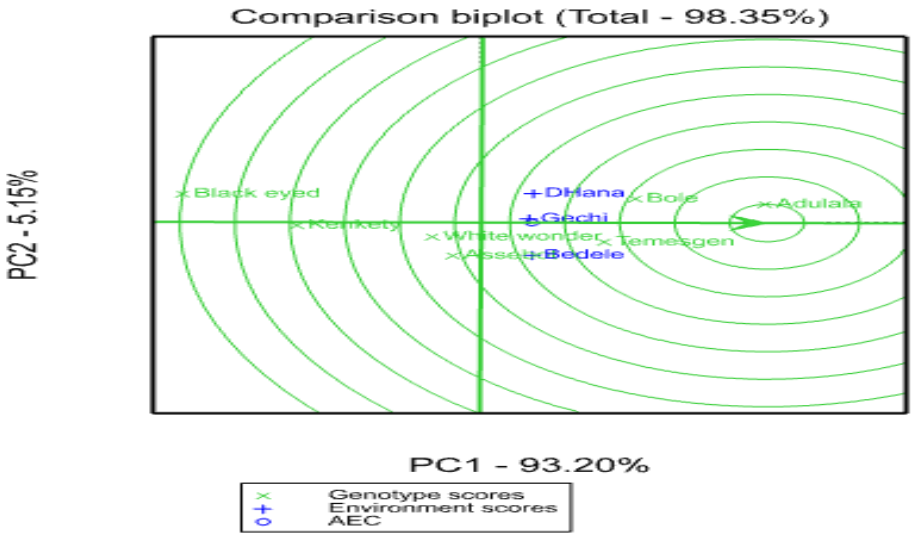

Table.1 Analysis of variance for yield and yield related components of cowpea varieties tested in Bedele, Gechi and Dabo Hana districts, Buno Bedele Zone

Source of Variation	DF	Mean squares			
		Plant height (cm)	Dry matter yield (t/ha)	Maturity date	Seed yield (Qt/ha)
Replication	2	474	22.707	180.10	96.76
Varieties	6	5515**	88.888**	492.99**	553.20**
Location	2	2385^{NS}	79.974**	487.60**	609.82**
Year	1	71571.5**	127.802**	112.39*	123.95^{NS}
Varieties * Location	12	285^{NS}	3.303^{NS}	16.83^{NS}	92.15^{NS}
Varieties * Year	6	2080.8^{NS}	3.718^{NS}	267.41**	131.19*
Varieties * Location * Year	12	232.1^{NS}	4.870^{NS}	11.63^{NS}	102.92*
Error	82	903.6	4.899	25.01	46.50

Where, *, ** and *** shows a significant at 0.05, 0.01, and 0.001% respectively. DF: Degree of freedom

Table.2 Combined mean performance of cowpea yield and yield related components at Bedele, Dabo Hana and Gechi districts in two years (2021 and 2022)

Varieties	Plant height (cm)	Disease incidence (1-5)	Dry matter yield (t/ha)	Maturity date	Seed yield (Qt/ha)
Temesgen	137.8^{bcd}	1^{c}	12.14^{ab}	108.4^{a}	17.55^{a}
Adulala	179.1^{a}	1^{c}	13.91^{a}	107.3^{a}	17.19^{a}
Bole	135.4^{cd}	1^{c}	12.49^{a}	102.5^{bc}	16.62^{ab}
Assebot	133.4^{d}	2.6^{a}	10.47^{bc}	106.2^{ab}	10.69^{cd}
Kenkety	138.8^{bcd}	2^{b}	8.77^{cd}	94.3^{d}	21.13^{a}
White wonder	161.9^{ab}	1^{c}	10.28^{bc}	100.1^{c}	11.97^{bc}
Black eyed	159.5^{abc}	2.8^{a}	7.51^{d}	108.3^{a}	6.12^{d}
Mean	149.4	1.62	10.80	103.88	14.47
CV (%)	25.5	20.9	26.6	6.4	51.7
LSD (5%)	25.12	0.27	1.89	4.368	4.941

[1]CV=Coefficient of variation, LSD=Least significant difference, NS= Non significant, [2] Figure having the same letters with in column are not significantly differ, while values followed by different letter (s) are significantly differ

Table.3 Mean seed yield (qt/ha) of cowpea varieties tested at Bedele, Dabo Hana and Gechi districts in two years (2021 and 2022)

Varieties	Bedele		Dabo Hana		Gechi	
	2021	2022	2021	2022	2021	2022
Temesgen	13.827^{a}	15.53^{ab}	18.89^{ab}	13.60^{bc}	29.55^{a}	13.91^{ab}
Adulala	3.527^{b}	15.98^{ab}	8.27^{ab}	21.88^{a}	26.82^{a}	16.02^{ab}
Bole	20.010^{a}	15.19^{ab}	2.85^{b}	15.37^{b}	20.87^{a}	19.44^{a}
Assebot	5.420^{b}	4.85^{bc}	23.18^{a}	4.75^{de}	23.12^{a}	18.52^{a}
Kenkety	18.630^{a}	19.72^{a}	22.91^{a}	24.32^{a}	32.65^{a}	11.88^{b}
White wonder	5.537^{b}	15.31^{ab}	3.95^{b}	7.93^{cd}	19.94^{ab}	17.13^{ab}
Black eyed	1.927^{b}	1.14^{c}	10.01^{ab}	1.76^{e}	6.27^{b}	2.25^{c}
Mean	9.8	12.53	12.9	12.80	22.7	14.16
CV (%)	18.2	36.4	40.6	25.0	35.0	24.7
LSD (5%)	8.27	12.955	18.46	5.688	14.17	6.218

[1]CV=Coefficient of variation, LSD=Least significant difference, NS= Non significant, [2] Figure having the same letters with in column are not significantly differ, while values followed by different letter (s) are significantly differ

The result indicated that the lowest seed yield was recorded at Bedele district. The combined analysis result also indicated that the maximum (21.13 qt/ha) seed yield was recorded by Kenkety followed by Temesgen (17.55qt/ha), Adulala (17.19qt/ha) and Bole (16.62qt/ha) varieties (Table 2). The lowest seed yield was recorded by Black eyed (6.12 qt/ha) varieties. This result agreed with finding by (Tekle Yoseph, 2014), who reported seed yield of 5.87 qt/ha for Black eyed cowpea variety. Similar finding was also reported for the variety Black eye (Fikru and Hailemichael, 2006). On the other hands, the mean seed yield recorded in this experiment was incomparable with what was reported by Muthamia and Kanampiu, (1996).

Disease and pests occurrence

The occurrence of disease and pests was observed during the experimental period. Leaf rust and insect were occurred on Black eyed, Assebot and Kenkety varieties. Based on 1-5 scale, Black eyed Assebot and Kenkety varieties scored a mean value of 2.8, 2.6 and 2 respectively while the others varieties scored lower values (1.0) and relatively tolerated the occurrence of the disease (Table 2).

Stability performance of cowpea varieties

The result of forage biomass yield stability test for cowpea varieties evaluated at Bedele, Gechi and Dabo Hana districts was indicated in fig 1. Analysis of dry matter yield using the comparison GGE Biplot shows that Adulala, Bole and Temesgen varieties were the most stable and desired varieties as compared to the other varieties. The result indicated that these varieties were the most adaptable and performed best as compared to the remaining tested varieties in the test environments and similar agro-ecologies.

Conclusion and Recommendation

The study was conducted during 2021 and 2022 cropping season at three locations; Bedele, Gechi and Dabo Hana districts with the objective to evaluate and select the best adaptable and high dry matter yielders of cowpea varieties. The result revealed that dry matter yield, seed yield and other agronomic trait were significantly ($p<0.05$) differ among the tested cowpea varieties.These variation may be due to the differences in genetic potential and adaptability of the varieties. Among the tested varieties the maximum dry matter yield was obtained from Adulala (13.91 t/ha) followed by Bole (12.49 t/ha) and Temesgen (12.14 t/ha). On the other hands, the maximum (32.65qt/ha) seed yield was recorded by Kenkety followed by Temesgen (29.55Qt/ha) and Adulala (26.82Qt/ha) varieties at Gechi in 2021 cropping season. GGE Biplot analysis also shows that Adulala, Bole and Temesgen varieties were the most stable and desired varieties as compared to the other varieties. Hence, Adulala, Bole and Temesgen varieties would be recommended for further demonstration and production in the study area and similar agro-ecologies.

Conflict of Interest

The authors stated that there is no conflict of interest between authors and the organization.

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