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Full Length Research Paper

Advanced evaluation of cowpea (*Vigna unguiculata*) accessions for fodder production in the central rift valley of Ethiopia

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The experiment was conducted at Adami Tulu Research Center in 2004 with 37 selected lines of grain type cowpea (*Vignia* species) germ-plasm introduced from Melkassa Agricultural Research Center, Lowland Pulse Improvement Program for the advanced nursery trial. Dolichos lablab (*Lablab purpureius* both var. Highworth and Rongai) and cowpea (*Vignia ungiculata* var. white worder training type) were included as a control for herbage yield and quality evaluation and ranking. The top ten accessions of cowpea (IT82D 889, TUX 1948-01F, TVU 1142 4, IT85F 2687, 82D 504-4, IT84D-448, IT93K2046-2, IT87D 551-1, IITAUK91-12, 87D -1802,) and Dolichos lablab var. Rongai was selected using the visual observation data taken during the 2004 growing season and promoted for further advanced evaluation. Advanced evaluation was carried out during the growth period, 2005 and 2006, using randomized complete block design (RCBD) of three replication of plot size 3 × 2 m. Fresh weight yield, hay yield, grain yield of both years showed statistically significant difference among accessions (p<0.005) during both growing periods. There was statistically significant difference in percentage dry matter (DM%), percentage organic matter (OM%), percentage ash (ASH%) and percentage crude protein (CP%) (P<0.0001) and the highest value of 88.94, 79.32, 12.09 and 22.3% were shown by accessions IITAUK91-12, IT87D 551-1, 87D -1802 and IT93K 2046-2, respectively. The different accessions responded to the different seasons differently based on the rainfall duration in their herbage and grain yield that needs further categorization.

Key words: Adami Tulu, Dolichos lablab, herbage var. Rongai yield.

INTRODUCTION

As cultivated land becomes scarcer and fertilizer prices continue to rise, the increasing demand for food and animal feed must be met by raising the productivity of land already under cultivation. Legumes are the most important forage plants that substantially improve the feed available for livestock as they can provide the essential protein for animals, improving soil fertility food crop production and household nutrition through a more reliable supply of milk and meat (Alemayehu, 1997).

Adami Tulu is known by its agro pastoral farming system with maize as the major crop cultivated for food security while white haricot bean is cultivated as cash crop (ATRC, 1997). Cereals like maize, wheat, barley, tef and small plots of sorghum have been cultivated continuously on a single plot or one after the other without integration of any legume crop for several years. As a result, the fertility and then the productivity of the land have been declining. In addition, poor families have been frequently seen victimized by protein deficiency (ESAP, 2005). Previous efforts in Adami Tulu agricultural research center have shown a good potential forage legume like Dolichos lablab (*Lablab purpureus*) that

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enhance the intake and utilization of poor quality roughage and subsequently improved livestock production and productivity. However, due to high seasonal variation of rainfall in the area, it is difficult to produce herbage dry matter yield of more than 2.5 t/ha from the improved forage. Hence there is a need to search for alternate species that could serve more purpose.

Cowpea (*Vigna unguiculata L. Walp.*), is a leguminous plant belonging to the Fabaceae family. Cowpea is largely produced in Africa (80%) with Nigeria and Niger predominating, but Brazil, West India, Myanmar, Sri Lanka, Australia, the United States, Bosnia and Herzegovina all have significant production (Quinn, 1999). Cowpea, like other grain legumes is an important foodstuff in tropical and subtropical countries (Chinma et al., 2008) because of its use mainly as a grain crop, a vegetable or fodder for animals. Although it occupies a smaller proportion of the crop area than cereals, cowpea contributes significantly to household food security in West and Central Africa (Langyintuo et al., 2004). It is grown under rain-fed conditions in the tropics (Sangakkara, 1998), for its high protein content and is consumed as dry seeds, green pods or leaves. The residues of the plant are used in animal feeding. Also, cowpea can be used as a summer fodder crop fed as fresh or hay. Nutrients provided by cowpea make it extremely valuable where many people cannot afford proteins from animal sources such as meat and fish (Akpapunam and Sefa-Dedeh, 1997). Nigeria is the largest producer and consumer of cowpeas, accounting for about 45% of the world's cowpea production. Cowpea is referred to as the "hungry-season crop" given that it is the first crop to be harvested before the cereal crops are ready. It is a crop that offers farmers great flexibility. They can choose to apply more inputs and pick more beans, or - if cash and inputs are scarce - they can pick fewer beans and allow the plant to produce more foliage. This means more fodder for livestock, so that lower bean yields are balanced by more livestock feed, which in turn translates into more meat and milk. This flexibility in use makes cowpea an excellent crop under the challenging climatic conditions faced by African farmers (Okike, 2000). Cowpea fixes atmospheric nitrogen up to 240 kg/ha and leaves about 60 to 70 kg nitrogen for succeeding crops (CRI, 2006). Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky et al., 2002; Tarawali et al., 2002; Sanginga et al., 2003). Cowpea is highly valued for its ability to tolerate drought and the high protein content of about 25% (IITA, 2007). These qualities make it a choice crop for catering for the food security needs of societies. Cowpea plays a critical role in the lives of millions of people in Africa and other parts of the developing world, where it is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valuable and dependable commodity that produces income for farmers and traders (Singh, 2002; Langyintuo et al., 2003). Integration of cowpea with the prevailing farming system could have significant importance in improving soil fertility and productivity, improving feed quality and withstand the effect impact of climate change. Therefore, this advanced evaluation was conducted with the objective of identifying productive dual purpose cowpea genotypes for the mid rift valley of Ethiopia.

MATERIALS AND METHODS

The study was conduct at Adami Tulu Research Centre located at 7º9̇N and 38º7'E in semi-arid rift valley of Ethiopia. The mid-rift-valley of Ethiopia is the part of great rift-valley that runs from northeast to south of the country and separates the western and southeastern highlands. The highlands on each side of rift valley give way to extensive semi-arid lowlands to the east, south and west of the country. The area at an elevation of 1650 m asl receives variation in seasonal rainfall distribution with an average annual precipitation of less than 760.9 mm. The mean annual temperature is 26ºC with a mean minimum and maximum of 12.7 and 29.2ºC, respectively. The soil is fine sandy loam with sand silt and clay in the proportion of 34, 48 and 18%, respectively (ATARC, 1998).

The experiment was conducted with 37 selected lines of grain type cow pea (*Vignia species*) germ-plasm introduced from Melkasa Agricultural Research Center's low land pulse improvement program for the advanced nursery trial. Dolichos lablab *(L. 0purpureius* both var. Highworth and Rongai) and cowpea (*Vignia ungiculata* var. white worder trailing type) were included as a control for herbage yield and quality evaluation and ranking. The selected *V. ungiculata* species germ-plasm were grown as experimental treatment in a Randomized Complete Block Design(RCBD) of three replications and plot size 3 x 2m with an inter-row and intra-row spacing of 60 and 20 cm. Recommended fertilizer rate (100 kg DAP/ha) and weeding (two times before flowering) was practiced.

At 50% flowering stage, the middle row of each plot was harvested for biological yield estimation. The pods were harvested from the rest rows at optimum physiological maturity by hand picking for grain yield. Sub-samples of the above ground biomass was ground to pass through 0.2 mm sieve and maintained for chemical determination. Percentage dry matter (DM%), percentage ash (ASH%) percentage organic matter (OM%), and percentage crude protein (CP%) were determined using AOAC (Association of Official Analytical Chemists), (1990) procedure).

RESULTS

Forage yield

The herbage yield of cowpea accessions and Dolichos lablab (control) is presented in Table 1. The differences among accessions fresh weight yield during the first and the second growing periods were found highly significant ($p<0.0001$ and $p<0.005$), respectively. During the first year growing period, 29.09, 26.86 and 26.69 t/ha were obtained from accessions 87D -1802, IT82D 889 and TVU 1142 4, respectively. In the same way, during the second year growing period, highest fresh matter yield of 32.22, 29.16 and 26.60 t/ha were obtained from accessions 87D -1802, TVU 1142 4 and IT87D 551-1, respectively. From the two years, relatively high fresh

Table 1. Herbage and grain yield of different cowpea accessions and Dolichos lablab .

ATRC. acc no.	Accessions.	Fresh weight (t/ha)		Hay (t/ha)		Grain yield (Quantity/ha)	
		Year-1	Year-2	Year-1	Year-2	Year-1	Year-2
12	Dolichos lablab	12.37^{de}	14.57^{d}	5.1^{bc}	5.29	4.49^{ef}	5.98^{de}
64	87D -1802	29.09^{a}	32.22^{a}	7.67^{a}	6.98	10.12^{a}	11.47^{a}
65	IITAUK91-12	11.10^{e}	17.89^{cd}	3.12^{ef}	5.34	5.83^{cd}	4.47^{ef}
67	IT87D 551-1	16.16^{cde}	26.60^{abc}	3.31^{def}	6.35	4.93^{de}	6.05^{de}
69	IT93K2046-2	13.38^{de}	19.38^{cd}	4.65^{bcde}	4.89	7.63^{b}	9.17^{b}
74	IT84D-448	22.90^{abc}	22.94^{bcd}	4.29^{bcdef}	5.79	7.05^{bc}	9.07^{b}
75	82D 504-4	25.47^{ab}	26.31^{abc}	5.44^{b}	7.12	3.71^{f}	3.95^{f}
83	IT85F 2687	22.84^{abc}	24.13^{abc}	4.92^{bcd}	5.86	6.17^{cd}	6.57^{cd}
86	TVU 1142 4	26.69^{ab}	29.16^{abc}	3.62^{cdef}	5.98	5.02^{de}	5.69^{def}
89	TVX 1948-01F	19.68^{bcd}	17.86^{cd}	3.53^{cdef}	5.53	5.00^{de}	5.66^{def}
94	IT82D 889	26.86^{ab}	26.32^{abc}	2.78^{f}	5.87	6.73^{bc}	7.97^{bc}
	$\bar{x}$	20.59	23.4	4.4	6.91	6.06	6.91
	CV%	21.32	20.26	19.83	15.62	11.23	15.62
	P-level	0.0001	0.005	0.0001	NS	0.0001	0.0001

*Means in the same column followed by different letters are significantly different **at** œ = 0.05.

matter average mean yield (23.4 t/ha) was obtained during the second growing period.

Dry matter herbage yield was significantly different for first year (p<0.0001) and not for second growing year at œ = 0.05. During the first year growing period, highest hay yield of 7.67, 5.44, and 5.1 t/ha was obtained from accessions 87D-1802, 82D 504-4 and the control (Dolichos lablab), respectively. Although the hay yield data during the second year growing period did not show statistically significant difference, relative high hay yield of 7.12, 6.98, and 6.35 t/ha was obtained from accessions 82D 504-4, 87D-1802 and IT87D- 551-1, respectively. As of fresh matter yield, high hay mean yield (5.91 t/ha) was obtained during the second year growing period due to the same reason. Both the shortage and extension of rainfall brought yield difference among accessions (Figure 2).

Grain yield

The *Viginia* accessions considered in this study were found superior in their grain yield in comparison to Dolichos lablab. The two year data presented (Table 1) were found highly significant (p<0.0001). The highest grain yield of 10.12, 7.63 and 7.03 Qun/ha were obtained during first year growing period from accessions, 87D -1802, IT84D-448 and IT93K2046-2, respectively (Table 1). Similarly during the second year growing period, highest yield of 11.47, 9.17 and 9.07 Qun/ha was obtained by the same accessions, respectively. The higher average mean grain yield (6.91 Qun/ha) was obtained during the second year growing period, due to fair distribution of rain during the growth months (Figure 1) that resulted in limited pest problem on majority of accessions.

Nutritional compositions

There were statistically significant difference among cowpea accessions and between accessions and Dolichos lablab (the control) in DM, ash, OM and CP% at (P< 0.0001) level of significance. Only one cowpea accession (acc. IITAUK91-12) was found outstanding (88.94%). The control (88.69%) and all the rest cowpea accessions were not significantly different (p>0.05) in their DM% with lablab and among each other. In their ash%, two of the cowpea accessions were underscored (Table 2) and the rest were superior to the control (Dolichos lablab). Accessions, 87D -1802, TUX 1948-01F and IITAUK91-12 were the top three accessions with 12.09, 11.99 and 11.73%, respectively (Table 2). OM% of only one accession of cowpea (IT87D 551-1) was found superior (79.32%) to the control (79.02%) and followed by accession IT85F 2687, (78.21%). The highest CP% was obtained by accession IT93K 2046-2 followed by accessions, IITAUK91-12 and 87D -1802 with corresponding values of 22.3, 22.17 and 21.13%, respectively. In this study, except one cowpea accession, all the rest were found superior to Dolichos lablab in their CP% showing that cowpea is more nutritious than Dolichos lablab.

Disease and pest

The disease observed on the crop during the experimental period was leaf spot. In comparison to lablab cowpea accessions were highly susceptible (Figure 3).

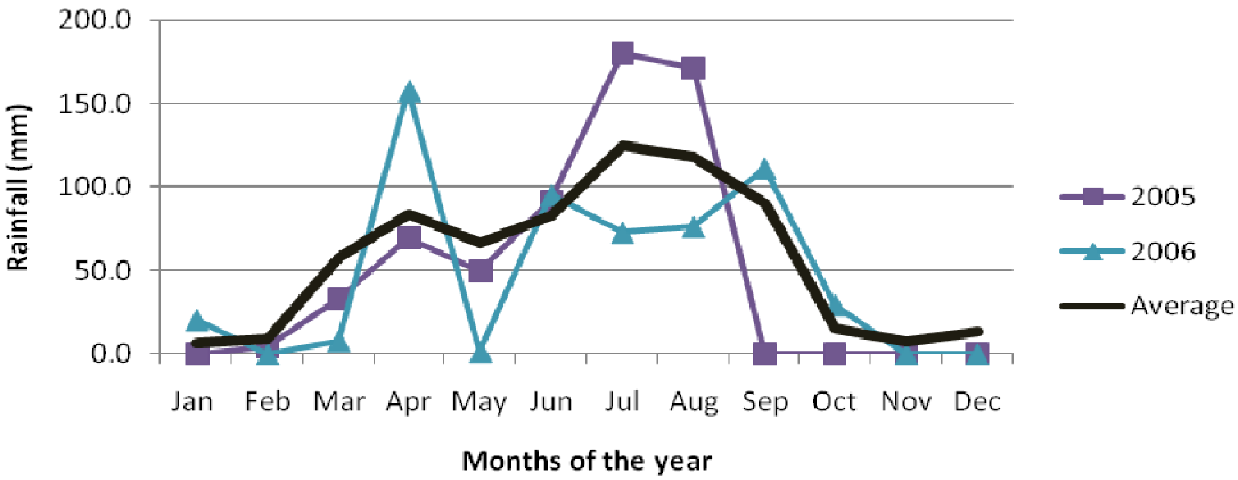

Figure 1. Monthly average rainfall distribution of the study site during the trial period.

Table 2. Mean Percentage dry matter (DM%), percentage ash (ASH%) percentage organic matter (OM%), and percentage crude protein (CP%) of composite sample of the two years (2005 and 2006) of cowpea accessions and Dolichos lablab.

ATRC acc. no.	Accession	DM%	ASH%	OM%	CP%
12	Dolichos lablab	88.69 [ab]	9.67 [d]	79.02 [d]	19.23 [d]
64	87D -1802	87.72 [ab]	12.09 [a]	75.75 [de]	21.13 [b]
65	IITAUK91-12	88.94 [a]	11.73 [ab]	77.24 [cd]	22.17 [a]
67	IT87D 551-1	88.31 [ab]	9.35 [d]	79.32 [a]	20.18 [c]
69	IT93K2046-2	87.88 [ab]	11.37[abc]	76.01 [de]	22.3 [a]
74	IT84D-448	87.16 [b]	9.30 [d]	77.86 [bc]	19.25[d]
75	82D 504-4	88.56 [ab]	11.3 [abc]	77.26 [cd]	20.85 [b]
83	IT85F 2687	88.74 [ab]	10.55 [c]	78.21 [abc]	20.18 [c]
86	TVU 1142 4	87.51 [ab]	11.16[bc]	76.35 [de]	19.43 [d]
89	TUX 1948-01F	87.33[ab]	11.99 [ab]	75.37 [e]	19.22 [d]
94	IT82D 889	87.42 [ab]	10.52 [c]	76.9 [cd]	19.76 [d]
Mean		88.02	10.82	77.21	20.33
CV%		0.95	4.32	1.03	1.9
P-level		0.0001	0.0001	0.0001	0.0001

*Means with the same letter in the same column are not significantly ($p<0.05$) different.

The common pests observed during the experimental period were cut worm and aphid. Cutworm mostly damaged when the seedlings were at their flag leaf stage and aphid's invasion occurred during early maturing on flag shoots and immature green pods.

DISCUSSION

The result is in agreement with the finding of Mohammad et al. (1993) who reported green fodder yield of cowpea of different accessions ranging between 16.49 to 26.02 t/ha in experiment conducted in Islamabad. When the rainfall was limited, those relatively late maturing accessions faced pest problem. Contrary to this, FAO (1988) indicated that during fair distribution of rainfall, the relatively late maturing accessions got advantage, while those relatively early maturing faced disease problem that led to final yield reduction and brought yield variation of the same accession between growing seasons (Table 1). The current result is in agreement with the report of Farming System Research and Extension Unit (1999) that stated that pests can severely reduce cowpea grain yield. Cowpea grain yield average only 200 to 400 kg/ha in Uganda (Sabiti et al., 1994; Omongo et al., 1997), and 200 to 300 kg/ha in Nigeria (Alghali, 1992) which was by far below the yield recorded in this study. Nelson et al. (2008) stated that cowpeas can have yield potential up to

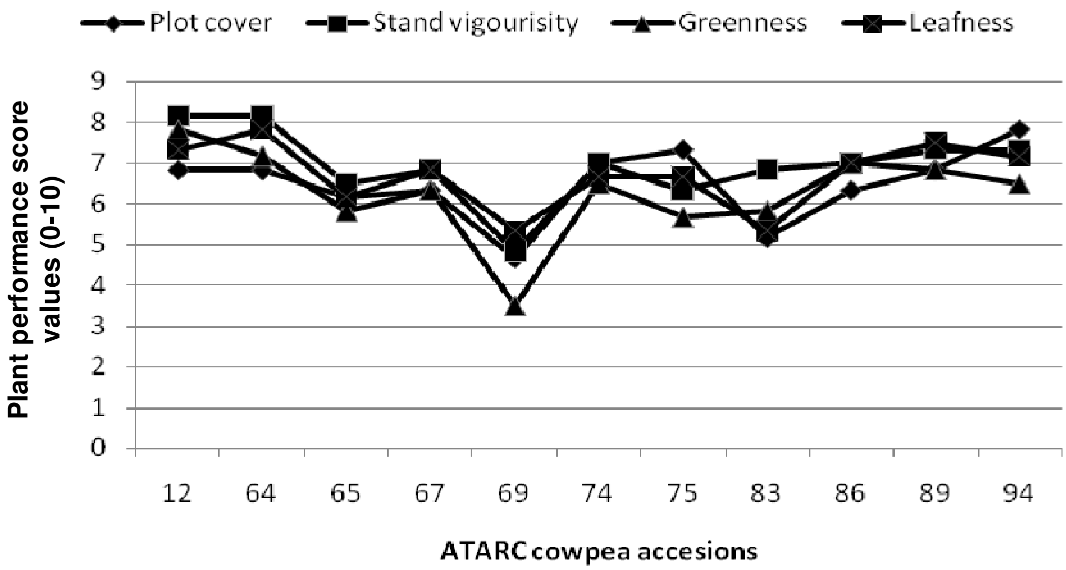

Figure 2. Growth characteristic of the accessions. Score: 0 = Poor condition; 10 = good condition.

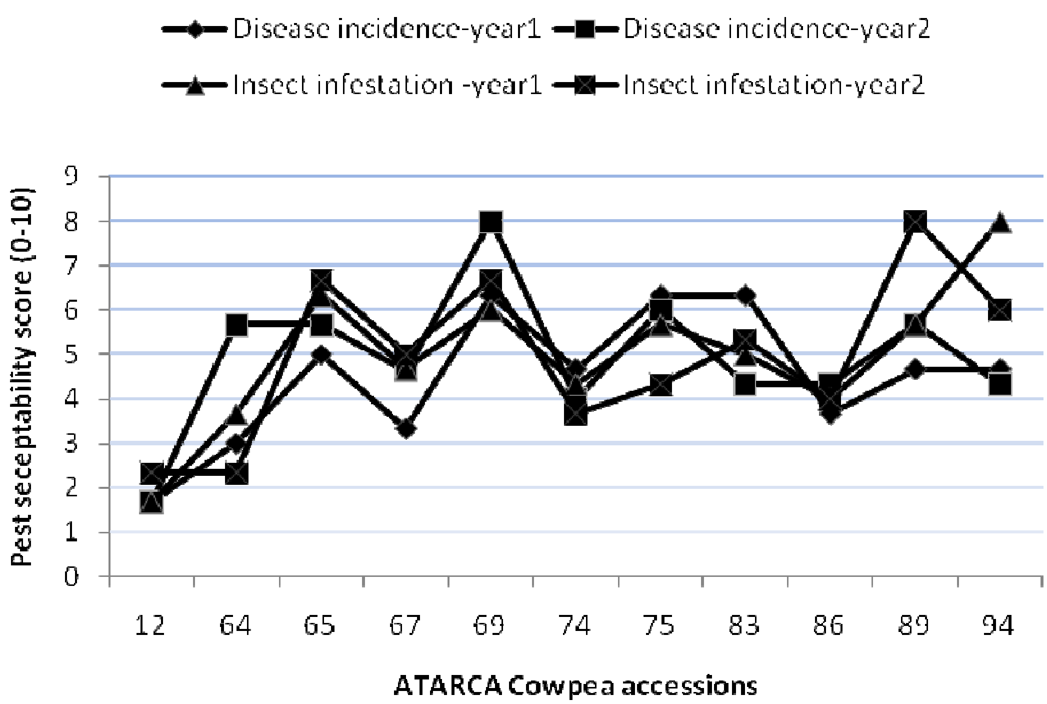

Figure 3. Pest and disease susceptibility level of the cowpea accessions and Dolichos lablab var. Rongai. Score: 0 = Resistant, 10 = highly susceptible.

2969 kg/ha in laboratory biosphere but most accessions grain yield under field condition ranges 6.38 to 11.21 Qunt/ha (Davis et al., 1991), which is almost similar to what was obtained in the present study. Similar finding was reported by Gwanzura et al. (2012) who showed that Dolichos lablab exceeds cowpea in its DM% and OM%, while these were high in cereals like sorghum. The OM and DM% demand of livestock in mid-rift-valley can be easily compensated by the major basal diets used viz. maize stover, tef straw and wheat straw. Based on their CP% content, Gwanzura et al. (2012) suggested that both cowpea and lablab have potential of being utilized as protein supplement for ruminants on low quality roughages. Ebro et al. (2004) envisaged in their study of legume supplementation that protein-N sources such as oilseed cakes and those of animal origin are produced in limited quantities and are beyond the economic reach of most of the small holder farmers in Ethiopia. The same authors realized that 0.5% level of supplementation of calves with cowpea hay stimulated the voluntary intake of tef-straw which as a result could bring an intermediate level of animal production. Gwanzura et al. (2012) supported this idea based on the high concentration of anti-nutritional factor (tannin) in Dolichos lablab (0.05%) than in cowpea (0.03%). Abule et al. (1995) confirmed that cowpea had similar degradation characteristics, rumen ammonia concentration, rate of degradation of teff straw, mean retention time, particulate passage rate and dry matter intake compared to lablab. Consumption of foods based on these cowpea varieties would be important step towards alleviating protein malnutrition (Appiah et al., 2011). Agfacts (2003) stated that lablab is relatively free of diseases such as root rots and foliar diseases while cowpea is susceptible to phytophthora stem and root rot that can be a serious disease and aggravated by poor drainage conditions. Although the incidence of cut worm on cowpea has been little stated, aphids are repeatedly reported as the common pest of cowpea all over the world during the growing season (Farming Systems Research and Extension Unit, 1999). This was observed during the first growing season when rain was stopped before the normal time. This was in agreement with Nabirye et al. (2003) investigation that aphid, pod borer and pod sucking bug are common pests of cowpea among which incidence of aphid is highly dependable on rainfall situation. Moreover, Nabirye et al. (2003) depicted that aphid incidence can be reduced by intercropping cowpea with cereal crops like sorghum.

Conclusion

Considerable variation exists among accessions, indicating the potential for selecting superior genotypes for both forage and grain (dual purpose). Some accessions showed variation in both herbage and grain yield with varying rainfall distribution and amount. High average herbage and grain yield was obtained not by high amount and short rain but with uniform distribution of rainfall during the growing period. The termination of rain earlier than the normal time exposes the crop to high infestation of pests, from which, aphid is of importance. A great variation existed among herbage and grain yield than the chemical composition (DM%, OM%, ASH%, and CP%) of the accessions. Cowpea is more nutritious than lablab and can supplement deficient roughage feeds. Dual-purpose cowpea species are the appropriate crop for the Adami Tulu area where the rainfall situation is erratic and irregular and agro-pastoral farming system is practiced. When the rain extends from the normal time, most species inclined to more of herbage yield.

RECOMMENDATIONS

Ranking and then promoting of cowpea in mid rift valley of Ethiopia should focused on herbage and grain yield. Based on that, accessions 87D -1802, IT82D 889 and TVU 1142 4, were ranked in decreasing order of importance and promoted for further agronomic evaluations for the study area and similar agro-ecologies. From the very nature, cowpea is a low yielder and its sole cultivation is not common and recommended to be sown mixed with cereals. So, it is recommendable that these accessions be evaluated for their intercropping potentials before promoting to end-users.

Cowpea is not a common crop even for its fodder value in rift valley of Ethiopia; however when it was taken to Mieso district through Integrated Project Managemebt Solutions (IPMS) project and Fentale district by Animal Feeds Research Team of Adami Tulu Research Center for demonstration at the end of this trial, people were found giving rather high value as a food crop (personal communication). In addition, giving due attention as food crops and less priority as forage crops by farmers limited extension of forage crops in most parts of Ethiopia. These all show that further research have to give due attention in identifying dual purpose than on sole purpose accessions in future animal feed improvement program.

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