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Full Length Research Paper

Determination of row spacing and diammonium phosphate fertilizer rate for cow pea in selected districts of Southern Ethiopia

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The production package is blanket for cow pea in Ethiopia until recently. To address the problem of lack of location specific production packages for cowpea, field experiments were conducted during the rainy seasons of 2014 and 2015 with objective of evaluating the yield and agronomic performance of cowpea varieties under varying row spacing and DAP (Diammonuim phosphate) application rates. The experiments consisted of four levels of P2O5 in the form of DAP (0, 23, 46 and 69 kg P2O5 ha^{-1}) and four row spacing (40, 50, 60 and 70 cm). The sixteen treatment combinations were laid out in a randomized complete block design with three replications. The results of two way interaction showed that number of pods per plant, plant height, seed yield **per unit area, 100 seed weight and** biomass yield **per unit area were significantly increased due to 40 cm row spacing in all the years of the experiment. Similarly, there was significant (P<0.05) increase in plant height, pods/plant and grain yield/m^{2}due to 50kg/ha DAP, the result of which was invariable to 50 to 200kg/ha DAP. Wider to intermediate rows and higher fertilizer rates produced highest hundred seed weight (HSW) where as HSW was lowest due to narrower rows and lower fertilizer rates. Therefore, production of cow pea in Amaro and Hawasa areas may be carried out using 40 cm row spacing and 50 kg/ha DAP both in belg and meher seasons.**

Keywords: Cow pea, diammonium phosphate, row spacing, grain yield, biomass yield, package

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INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important grain legumes which is widely cultivated in semi arid areas of the tropics and subtropics. The crop is grown in drier areas in sandy and clay soils where rainfall is low. It is grown to produce dry grain, edible pods, edible leaves, hay or forage, or as green manure crop among farming communities in Africa. It is afast growing crop that fixes atmospheric nitrogen, its decaying residue and deep roots contribute to soil fertility and erosion control. Cowpea grains contain between 17 and 32% protein on a dry weight basis and it is one of the cheapest sources of protein in the diets where cowpea is an important crop.

The productivity of cow pea is low with average yield ranging from 100 to 400kg/ha. The low yields are due to several biotic and abiotic constraints as well as due to cultivation of cow pea as intercrop with cereals in marginal environments where input use is low (Henreit *et al.,* 1997). Crop and forage improvement programs have resulted in various cultivars/varieties In Ethiopia. However, the promotion works were not carried out at larger scale due to lack of complete set of technology packages. The objectives of this experiment was to determine optimum level of DAP fertilizer and row spacing that maximize yield of cow pea

MATERIALS AND METHODS

The experiment was carried out from 2012 to 2014 in sandy loam soils of *Hawassa chefe kote Jabesa* (latitude- 1700 m *a.s.l,* 7^0 04` N latitude, $38^0$31` E longitude, soil type – sandy loam) and *Amaro bulto* (latitude – 1430m *a.s.l.* , 06°05′N latitude, 38.033°E

Table 1: Means of PH, seeds/pod, pods/plant, HSW, Grain yield and Biomass yield of cow pea as affected by row spacing and diammonium phosphate

Row spacing (cm)	Plant height (cm)	Seeds/pod	Pods/plant	Grain Y (kg/ha)	Biomass Y (kg/ha)	HSW (g)
40	57.4	9.62	11.5	1190	8070	16.48
50	54.1	9.58	12.3	950	5760	16.41
60	54.7	9.21	12.9	960	5950	16.96
70	53.9	9.25	13.5	1030	6810	16.60
LSD (%)	1.76**	NS	1.007**	69**	79**	0.398*
Diamonium phosphate (kg/ha)						
0	54.9	9.23	12.9	1050	6810	16.49
50	56.6	9.67	12.4	1080	6730	16.57
100	54.4	9.47	12.9	1040	6780	16.68
150	55.5	9.39	12.3	990	6750	16.86
200	53.7	9.34	12.4	1010	6160	16.46
LSD (%)	**1.98***	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**10.9**	**16.08**	**27.4**	**23.12**	**40.60**	**8.17**

*HSW=Hundred seed weight, LSD= least significance difference, NS, *, **= Non significant difference, significance at 1 and 5% level of probability*

longitude with an altitude of 1490 meters above sea level and clay loam soil type) in Southern Ethiopia with the objective of determining optimum level of DAP fertilizer and row spacing that maximizes cow pea production. Four levels of DAP (Diammonium phosphate) fertilizer 0, 50, 100, 150 kgha^{-1} DAP and four levels of row spacing 40, 50, 60, and 70 cm were laid in Randomized Complete Block Design with three replications using 4 x 4 factorial arrangements. The cow pea cultivar employed in the study was *Maze (IT (98k-131-20)),* released by Hawasa Agricultural Research Center in 2006. Planting was done with the onset of rain in both rain seasons locally called *belg* (a season of short rains and starts in February) and *meher (*a season of longer rains and starts in July*)*. The seeds were drilled in respective row and later thinned to 10 cm plant spacing after emergence. Plant height, seeds/pod and pods/plant of cow pea were measured during physiological maturity from consecutive five plants grown in central rows where as hundred seed weight, grain and biomass yields were estimated after harvesting plants of net plot area. Grain and biomass yields were converted to per hectare basis for comparison. *Dimethiote* and *Redomil* were sprayed for s control of ants and termites, and powdery mildew that occurred in dry and rainy times, respectively. The collected data were statistically analyzed using the PROC ANOVA function of SAS and means were compared using LSD at a probability level of 5% and 1%.

RESULTS AND DISCUSSIONS

Main effects of row spacing x diammonium phosphate fertilizer application

Row spacing

The response of plant height ($p<0.01$), pods/plant ($p<0.01$), grain yield ($p<0.01$) and biomass ($p<0.05$) were significant to main effects of row spacing. Conversely, the main effects of row spacing did not result in significant ($p<0.05$) effect on number of sees/pod. Results showed that significantly higher plant height (57.4cm), grain yield (11.9q/ha) and biomass yield (80.7q/ha) were measured due to 40 cm row spacing compared to other row spacing levels (Table 1). The higher magnitude of grain yield was due to taller plants possessing more seeds/pod and greater biomass in lower populations. However, significantly higher pods/plant (13.5) was measured due to 70 cm row spacing. However, number of pods/plant were invariable due to row spacing of 60 cm and 70 cm. significantly lowest number of pods/plant were measured due to narrow rows of 40cm. Hundred seed weight (HSW) (16.96g) were significantly highest due to 60cm row spacing compare to other levels of row spacing (Table 1).

Main effect of diammonium phosphate

The response of seeds/pod, pods/plant, grain yield, biomass and HSW were not significant ($p<0.05$) to effects of Diamonium phosphate. Absence of response to DAP may be attributed to phosphorus fixation, high inherent phosphorus levels in *Hawasa* and *Amaro* areas or high amount of external fertilizer supplementation in the testing sites in the preceding seasons (Table 1).

Row spacing x diammonium phosphate interaction effects

Two way interactions effects were significant on plant height ($p<0.01$), grain yield ($p<0.01$) and HSW ($p<0.01$) where as row spacing x diammonium phosphate interaction were not significant ($p<0.05$) on seeds/pod, pods/plant and biomass yield. Similarly, highest grain yield (12.3q/ha) was measured due to 40 cm wide rows

Table 2: Means PH, seeds/pod, pods/plant, HSW, Grain and Biomass yield of cow pea as affected by two way interaction of row spacing and diammonium phosphate

Row spacing (cm)	Diammonium phosphate (kg/ha)	Plant height (cm)	Seeds /pod	Pods /plant	Grain Y (kg/ha)	Biomass Y (kg/ha)	HSW (g)
40	0	54.96	9.70	11.93	1230	7750	16.19
40	50	59.40	10.31	11.09	1280	8370	16.66
40	100	55.85	9.53	11.83	1220	8340	16.73
40	150	58.84	9.19	10.92	1040	8580	16.42
40	200	57.98	9.41	11.73	1160	7320	16.39
50	0	52.60	9.19	11.97	1020	6040	15.67
50	50	52.02	10.29	11.42	1020	5720	16.43
50	100	55.05	9.60	13.64	940	5760	16.51
50	150	57.87	9.54	12.09	940	5620	17.17
50	200	53.09	9.29	12.14	850	5640	16.26
60	0	52.62	9.23	12.46	870	6720	17.59
60	50	58.16	9.04	13.64	930	5850	17.15
60	100	54.22	9.16	12.63	950	5730	17.47
60	150	51.99	9.28	13.77	920	5990	16.69
60	200	52.83	9.33	11.81	1130	5440	15.91
70	0	56.07	8.79	15.24	1070	6740	16.51
70	50	56.78	9.03	13.23	1080	6970	16.04
70	100	52.49	9.59	13.49	1060	7280	16.01
70	150	53.22	9.55	12.38	1050	6830	17.14
70	200	51.00	9.31	13.28	920	6230	17.27
LSD (%)		**3.95****	**NS**	**NS**	160*	**NS**	**0.89****
CV (%)		**10.95**	**16.08**	**27.38**	**23.12**	**40.60**	**8.17**

PH= plant height, HSW=Hundred seed weight, LSD= least significance difference, NS, *, **= Non significant difference, significance at 1 and 5% level of probability

Table 3: Mean Biomass (kg/ha) of cow pea as affected by location and row spacing

Row spacing (cm)	*Amaro meher*	*Amaro belg*	*Hawasa Meher*	*Hawasa belg*
40	5240	9760	9220	8240
50	4940	6110	7220	7430
60	4610	5880	7350	7240
70	4240	5900	7290	6140
LSD (%)	**1370****			
CV (%)	**40.60**			

x application of 50 kg/ha DAP compared to other application levels (Table 2). The grain yield due to 40 cm wide rows x 50 to 200kg/ka DAP were statistically invariable. Significantly lowest grain yield was observed due to widest rows (70cm) and highest fertilizer rates (200kg/ha DAP considered in the study. Results also revealed that plant height were tallest due to 40 cm wide rows x 50 kg/ha DAP compared to other levels of the two way interaction. The lowest plant height were due to widest rows and highest fertilizer rates. Thus 40 cm wide rows that received 50 kg/ha DAP were found to outperform other treatment combination in this study.

Cow pea was grown successfully in both locations and seasons mainly because *Amaro* areas received annual total rainfall of 750 to 818mm per annum where as *Hawasa* areas receive 1000 to 1200 mm per annum distributed in bimodal way. In *Amaro*, *belg* production (planting in first two weeks of March) was better compared to *meher* production (planting in last week of August). In Ha*wasa*, *meher* production (July planting) produced better biological yields compared to *belg* production (Mid March to mid April) (Table 3). This was due to occurrence of fungal leaf diseases at vegetative stage in *belg* productions in Hawasa areas.

The interaction effect of location x row spacing was very highly significant ($p<0.01$) on grain yield of cow pea. Results indicated that averaged over seasons and DAP rates, 40 cm row spacing produced significantly higher yields compared to other rows in all locations. Significantly lower grain yield/unit area was measured due to 70 cm row spacing compared to other row spacing. Thus wider rows resulted in lower yields unlike narrow rows. However this study has not explored what it would have happened if the row spacing was decreased further from 40 cm in either location (Table 3). This result agrees with Joseph *et al.* (2011) who identified narrow rows suitable for cow pea growth while attributing it to weed suppression.

SUMMARY AND CONCLUSION

Higher cow pea biomass was produced in Hawasa area (altitude 1700m *asl*) compared to *Amaro* (altitude 1490 m *asl*). This might be due to higher altitude and more rainfall resulting in extended growth period of cow peas. In *Amaro*, belg planting (Mid March) produced higher biomass compared to meher planting (Last week of August). This is attributed to greater relative rainfall spell in former season compared to the later. However, production of cow pea in both seasons requires appropriate fertilizer recommendations and has great significance in food and feed security of human and livestock populations of the respective areas. 40 cm row spacing consistently produced higher ($p<0.01$) grain yield and biomass in all locations compared to other row spacing considered in the study. Similarly, 50 kg/ha DAP has produced equivalent yield of cow pea to that of higher levels of DAP. Thus 50 kg/ha DAP might suffice for cow pea *var Maze (IT (98k-131-20))* production in Hawasa and *Amaro* areas and other locations of similar agro-ecologies.

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