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RESEARCH ARTICLE

EFFECT OF SEED RATE AND VARIETIES ON VEGETATIVE GROWTH ATTRIBUTES OF COWPEA (*Vigna unguiculata* L.Walp) UNDER RAIN-FED IN SUDAN

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Seed rate play an important role in the proper stand establishment of the growing crop, which ultimately affect the productivity and quality at the end of the growing season. The effect of seed rate on three cultivars were investigated in field trial in two successive seasons (2006/07 and 2007/08) at North Kordofan of Sudan, to determined the optimum seed rate for vegetative growth characteristic of cowpea under rainfed. Buff, Haydoob and Eien Elgazal cultivars were sowing in four seed rates of 6, 12, 18 and 24 kg ha^{-1}. The experiment was laid out in a randomized complete block design (RCBD) in four replications. The results revealed that, the seed rate had a significant effect on most of the vegetative growth attributes measured. Increasing seed rate increased plant height, decreased stem diameter, number of leaves per plant and leaf area index (LAI). The local cultivar (buff) had a significantly taller height, thicker stem diameter, greater number of leaves per plant and highest in leaf area index.

Key words: Seed rate, Leaf area index, Vegetative growth, Cowpea.

INTRODUCTION

Cowpea *(Vigna unguiculata* L.Walp.) is an ancient leguminous crop, which has been grown throughout the tropics and sub tropics. The cultivated species have been classified under the species unguiculata (Davis *et al.*, 1991). Conservative estimates suggest that greater than 12.5 million hectares are planted annually with cowpea around the world. The total world production is estimated about 3.3 million tons of dry grain (Singh *et al.*, 1997). The main producing countries of the cowpea crop are in West Africa. Basically, cowpea is a crop of the warm-season of the tropics and subtropics. It is adapted to high temperatures (20^0 – 30^0 C). The crop can be grown quite successfully under condition that are totally unsuitable for the common bean, it grows well in a wide range of soil texture, from heavy clays, if well drained, to sand (Hector and Jody, 2002). The optimum plant population of cowpea depends on many factors such as: rainfall, moisture and type of cultivars, available nutrient and management (El Naim and Jabereldar, 2010). Ndiaga (2000) concluded that cowpea cultivars with different plant morphology would require different optimum densities to express their full seed yield potential. In Sudan, cowpea is mainly grown under rain-fed conditions in Kordofan and Darfor state, which the rainfall ranged between 350 – 500 mm, only very small scattered batches had been grown under irrigation in the northern Sudan. Also it's grown

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extensively in the "Jubraka" system around the Nuba mountains (El Naim *et al.*, 2010[b]). The crop can give excellent yields of grain and fodder under irrigation and moderate stable yield under rain-fed condition. Cowpea can be grown as a sole crop in annual rotation with pearl millet, sorghum and even peanut or sesame. It can also grow successfully as a relay inter-crop with cereal or cash crops in mid August, if maturing varieties were used (El Naim and Jabereldar, 2010). Cowpea can be used as a feed (grazed, or harvested for fodder), or its pods can be harvested before maturity stage and eaten as a vegetable. The beans are nutritious and provide complementary proteins to cereals. Some people eat both fresh pods and leaves and the dried seeds are popular ingredients in various dishes (Hector and Jody, 2002). Cowpea seed contains (20 - 24%) protein, 63.3% carbohydrates and 1.9% fat (Davis *et al.*, 1991).

Cowpea hay is a rich feed for livestock in the dry season. Also as a legume, cowpea improves soil fertility and can be used as a trap crop in areas where Striga is a problem (Elawad, 2000). Cowpea grain and fodder yields are very low in West Africa and Sudan, the main problems limiting production and expansion of cowpea as pointed out by Elawad (2000) and El Naim and Jabereldar (2010) are: Low yield potential of existing cultivars, low density of cowpea and Limited use of certified seeds by the cowpea growers, due to deficient marketing and failure to convince the farmers about the advantages of planting certified seeds versus their own seeds. The current study carried out to investigate the effect of different seed rates and cultivars on vegetative growth of cowpea.

MATERIALS AND METHODS

A field experiment was conducted for two successive rainy seasons (2006/07 – 2007/08) at Elobeid, in North Kordofan state (latitude 11˚ 15' – 16˚ 30' N; longitude 27˚ – 32˚ E). The climate of the area is arid and semi arid zone. The mean annual rainfall ranges between 350 – 500 mm. The soil is sandy with low fertility. Average maximum daily temperature varied between 30˚ and 35˚ C through out the year (Gebauer, 2005). The experiment was laid out in a randomized complete block design with four replications. The experimental plot was 4×4meters. Treatments consisted of four levels of seed rates 6, 12, 18 and 24 kg ha^{-1}, designated as S_1, S_2, S_3 and S_4 respectively. Three cultivars of cowpea: Buff (local), Hydoob and Ein Elgazal (improved) were used and designated as V_1, V_2 and V_3 respectively. Sowing was on 27th of July, 2006 and 2007. Seeds were sown in holes at spacing of 60×30 cm. Manual weeding was practiced twice during both seasons.

A sample of five plants was taken randomly from central row in each experimental unit at 30 days after sowing (DAS), and then continued at an interval of 15 days to measure the following growth attributes:

- Plant height (cm): The height of the main stem from the ground level to the tip of the plant.
- Stem diameter (cm): measured by using a Vernier (caliper) at the first node.
- Number of leaves/ plant: by counting the number of leaves per plant.
- Leaf area index: Leaf area index (L.A.I) is a dimensionless quantity. It is the leaf area (upper side only) per unit area of land below. It is expressed as m^2 leaf area per m^2 ground area. Leaf area was determined using the punch method (Watson and Watson, 1953), by taking 50 discs and was calculated using the following relationship:-

$$\text{Leaf area} = \frac{\text{Total area of leaf discs x total dry weight of leaves}}{\text{Dry weight of leaf discs}}$$

The leaf area index (L.A.I), was determined as follows:-

$$\text{Leaf area index} = \frac{\text{leaf area per plant}}{\text{Plant ground area}}$$

Data were analyzed statistically using analysis of variance according to Gomez and Gomez (1984) procedure for a randomized complete block design. The differences of means were identified by Duncan's Multiple Range Test (DMRT) at $P \geq 0.05$.

Table 1. Effect of seed rate and cultivars on plant height (cm) of cowpea

Treatments	2006/07				2007/08			
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1	13.6	37.1^{a}	49.3^{c}	60.3^{d}	14.0^{a}	26.9^{b}	50.5^{c}	57.3^{c}
S_2	14.0	26.9^{b}	53.6^{a}	62.7^{c}	13.6	27.6^{b}	52.2^{b}	63.9^{b}
S_3	14.0	28.6^{b}	53.3^{a}	64.3^{b}	14.7	29.0^{a}	53.8^{b}	64.6^{b}
S_4	15.3	30.6^{b}	55.4^{a}	69.6^{a}	15.1	30.7^{a}	55.5^{a}	70.9^{a}
SE $\pm$	0.50	0.56	0.52	1.05	0.42	0.39	0.59	0.46
V_1	18.3^{a}	35.4^{a}	75.27^{a}	109.1^{a}	183^{a}	35.9^{a}	75.0^{a}	109.9^{a}
V_2	12.3^{b}	24.1^{bc}	39.28^{b}	39.7^{b}	12.2^{b}	23.4^{b}	39.3^{b}	38.8^{b}
V_3	$12.^{cb}$	25.4^{c}	44.21^{c}	44.3^{c}	12.5^{cb}	25.6^{c}	44.5^{c}	44.8^{c}
SE $\pm$	0.42	0.48	0.45	0.91	0.36	0.34	0.52	0.39
CV %	6.2	16.6	9.4	9.4	7.2	8.2	5.1	3.1

Similar letters are not significantly different at the 0.05 level of probability according to Duncan multiple range test

Table 2. Effect of seed rate and cultivars on stem diameter (cm) of cowpea

Treatments	2006/07				2007/08			
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1	0.22^{a}	0.35^{a}	0.41^{a}	0.49^{a}	0.24^{a}	0.36^{a}	0.47^{a}	0.47^{a}
S_2	0.20^{a}	0.27^{bcd}	0.32^{b}	0.33^{bc}	0.17^{a}	0.24^{b}	0.34^{a}	0.33^{b}
S_3	0.23^{a}	0.31^{cd}	0.34^{ab}	0.31^{cd}	0.18^{a}	0.24^{b}	0.34^{a}	0.33^{b}
S_4	0.20^{a}	0.27^{d}	0.40^{ab}	0.27^{d}	0.16^{a}	0.21^{b}	0.24^{b}	0.23^{b}
SE $\pm$	0.009	0.01	0.023	0.01	0.01	0.01	0.01	0.003
V_1	0.19^{a}	0.31^{a}	0.40^{a}	0.40^{a}	0.17^{a}	0.27^{a}	0.31^{a}	0.32^{a}
V_2	0.24^{b}	0.34^{a}	0.33^{a}	0.36^{a}	0.23^{b}	0.30^{b}	0.42^{b}	0.41^{b}
V_3	0.21^{a}	0.26^{b}	0.38^{b}	0.29^{b}	0.17^{a}	0.22^{c}	0.31^{c}	0.30^{c}
SE $\pm$	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.003
CV %	3.1	3.2	2.4	3.4	2.5	5.0	6.8	20.2

Similar letters are not significantly different at the 0.05 level of probability according to Duncan multiple range test.

Table 2. Effect of seed rate and cultivars on stem diameter (cm) of cowpea.

Treatments	2006/07				2007/08			
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1	0.22^{a}	0.35^{a}	0.41^{a}	0.49^{a}	0.24^{a}	0.36^{a}	0.47^{a}	0.47^{a}
S_2	0.20^{a}	0.27^{bcd}	0.32^{b}	0.33^{bc}	0.17^{a}	0.24^{b}	0.34^{a}	0.33^{b}
S_3	0.23^{a}	0.31^{cd}	0.34^{ab}	0.31^{cd}	0.18^{a}	0.24^{b}	0.34^{a}	0.33^{b}
S_4	0.20^{a}	0.27^{d}	0.40^{ab}	0.27^{d}	0.16^{a}	0.21^{b}	0.24^{b}	0.23^{b}
SE $\pm$	0.009	0.01	0.023	0.01	0.01	0.01	0.01	0.003
V_1	0.19^{a}	0.31^{a}	0.40^{a}	0.40^{a}	0.17^{a}	0.27^{a}	0.31^{a}	0.32^{a}
V_2	0.24^{b}	0.34^{a}	0.33^{a}	0.36^{a}	0.23^{b}	0.30^{b}	0.42^{b}	0.41^{b}
V_3	0.21^{a}	0.26^{b}	0.38^{b}	0.29^{b}	0.17^{a}	0.22^{c}	0.31^{c}	0.30^{c}
SE $\pm$	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.003
CV %	3.1	3.2	2.4	3.4	2.5	5.0	6.8	20.2

Similar letters are not significantly different at the 0.05 level of probability according to Duncan multiple range test.

Table 3. Effect of seed rate and cultivars on number of leaves per plant of cowpea

Treatments	2006/07				2007/08			
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1	12.2^{a}	15.5^{a}	43.0^{a}	40.7^{a}	12.0^{a}	15.6^{a}	38.7^{a}	42.3^{a}
S_2	10.6^{ac}	13.3^{ac}	30.1^{b}	34.0^{bc}	10.4^{ab}	15.3^{a}	32.9^{b}	35.6^{bd}
S_3	9.3^{cd}	11.1^{cd}	24.7^{c}	33.7^{c}	8.9^{bc}	12.0^{bd}	23.8^{cd}	32.6^{c}
S_4	7.7^{d}	10.7^{d}	27.3^{d}	37.2^{d}	8.0^{c}	11.4^{d}	27.5^{d}	34.4^{d}
SE $\pm$	0.64	0.61	0.59	0.79	0.47	0.27	0.98	0.39
V_1	13.0^{a}	16.2^{a}	53.7^{a}	72.0^{a}	12.5^{a}	16.3^{a}	53.7^{a}	68.1^{a}
V_2	8.4^{bc}	11.0^{bc}	22.3^{b}	22.5^{b}	8.3^{bc}	11.2^{bc}	22.2^{b}	24.5^{b}
V_3	8.5^{c}	10.8^{c}	17.3^{c}	14.2^{c}	8.2^{c}	12.0^{c}	16.1^{c}	15.2^{c}
SE $\pm$	0.55	0.53	0.30	0.68	0.41	0.46	0.84	0.33
CV %	52.6	2.6	8.9	3.7	6.0	13.3	5.0	3.6

Similar letters are not significantly different at the 0.05 level of probability according to Duncan multiple range test.

Table 4. Effect of seed rate and cultivars on leaf area index (L.A.I) of cowpea

	2006/07				2007/08			
Treatments	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
S_1	0.69^{a}	0.77^{a}	0.93^{a}	0,89	0.70^{a}	0.82^{a}	0.87^{a}	0.80
S_2	0.58^{bcd}	0.72^{a}	0.86^{b}	0.81	0.58^{bd}	0.71^{b}	0.89^{a}	0.87
S_3	0.62^{cd}	0.72^{a}	0.90^{ab}	0.89	0.63^{c}	0.71^{bc}	0.91	0.88
S_4	0.62^{d}	0.76^{a}	0.90^{ab}	1.02	0.59^{cd}	0.67^{bd}	0.93^{a}	1.01
SE ±	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02
V_1	0.72^{a}	0.84^{a}	1.01^{a}	1.16	0.70^{a}	0.79^{a}	1.01^{a}	1.03
V_2	0.57^{bc}	0.71^{bc}	0.82^{bc}	0.80	0.58^{b}	0.67^{b}	0.83^{b}	0.82
V_3	0.59^{c}	0.69^{c}	0.86^{c}	0.75	0.60^{bc}	0.72^{c}	0.86^{c}	0.84
SE ±	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02
CV %	4.5	6.4	2.4	6.8	4.7	5.3	6.7	7.9

Similar letters are not significantly different at the 0.05 level of probability according to Duncan multiple range test.

RESULTS AND DISCUSSION

Increasing seed rate increased plant height at all sampling occasions (Table 1). Similar results were obtained by Weber *et al.* (1966) who found that the plants produced at highest densities were taller and more sparsely branches. On the contrary, Mohamed (1994) and El Naim *et al.* (2010^{b}) reported that plant population had no significant effect on plant height. The local cultivar (Buff) had significantly taller plants in the two seasons compared to others. Differences among cultivars in plant height were reported by Miller (1988), Mohammed (1994), El Naim and Jabereldar (2010) and El Naim *et al.* (2010^{a}). Increasing seed rate decreased number of leaves per plant (Table 3). These results are in agreement with the previous findings reported by many workers (El Naim *et al.*, 2010^{abc}; Alege and Mustapha, 2007; Mohammed, 1984; Weber *et al.*, 1966). They showed that increased plant densities reduced the number of leaves per plant. The local cultivar (Buff) had the greatest number of leaves per plant than others. The leaf area index increased with the increasing seed rate (Table 4). Similar results were obtained by El Naim and Ahmed (2010) who found that leaf area index tends to increased with increasing seeding rate. This is because decreased seed rate resulted in increasing ground area more than increasing total leaf area of plant. The local cultivar (Buff) had the greater leaf area index than others. These results confirmed the findings of El Naim and Jabereldar (2010). Generally, increasing the plant population increased competition among plants for soil moisture, nutrient, light and carbon dioxide. Moreover, the low population plants grew as isolated units for most of their early life and interfered less with each other than at higher densities. This might explain the significant effect of seed rate on most of the parameters measured in the present study. Difference in growth attributes observed among cultivars may be to the growth habit and to the genetically potential of each genotype.

Conclusion

Based on the results obtained, the better growth performance of the cultivar Buff over the other cultivars in all seed rate, expected to gain maximum yield in North Kordofan of Sudan

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