Australian Journal of Basic and Applied Sciences, 4(11): 5516-5521, 2010
ISSN 1991-8178

Performance of Faba Beans (*Vicia faba L*) Cultivars Grown in New Agro-ecological Region of Sudan (Southern Sudan)

[1]Ahmed Ali Mohammed Osman, Samia Osman Yagoub and [2]Olway Awok Tut

[1]Department of Agronomy, Faculty of Agricultural Studies, University of Sudan for Science and Technology, Shambat, Sudan, Box,72. www.sustech.edu.
[2]Department of Crop Production, Faculty of Agriculture, Upper Nile University. Renk. Sudan

Abstract: Field experiments were conducted in (2004\05 and 2005\06) growing seasons in the Main Campus Farm of Upper Nile University (Malakal), to investigate growth and yield components of faba bean (*Vicia faba L*) cultivars, H-93, BB-7 and Sm-L, under Southern Sudan environment compared with the yield of recommended areas for commercial production of faba bean . The agronomical parameters (plant height, number of branches/plant, number of nodes/ plant, number of podded nodes /plant, number of the pods/plant, number of seed /pod , number of seed /plant, dry matter production, seed yield /plant, 1000 seed weight and yield kg/hectare were taken. The layout followed was the randomized complete block design with three replications. The temperature of Malakal was 29-37C. It was high compared with other recommended area of production of faba bean in Sudan. The results of growing three cultivars in Malakal environment revealed some differences for plant height but those differences were not significant for the two seasons. Meanwhile, the number of branches, number of nodes per plant and total dry matter revealed significant differences in the second season (2005/06) only. Number of podded nodes per plant was highly significant for the two seasons. For yield traits the number of seeds per plant and the number of pods per plant showed significant difference for the two seasons. On the other hands 100 seed weight and number of seeds per pod showed no significant differences for the two seasons that the traits were genetically controled and not affected by environment. BB-7, Sm-L and H-93 revealed higher productivity (2742 kg/ha, 3005 kg/ha and 2556 kg/ha) for the average of 4 locations while their productivity in Malakal was sharply declined to 702.3 kg/ha, 641.1 kg/ha and 928.6 kg/ha respectively. As general H-93 showed the highest values in growth and yields compared with the other cultivars. Significant differences were noticed between the two seasons and these encourage more research for appropriate sowing date and optimum watering intervals.

Key wards: faba bean, *Vicia faba.L*, cultivars, height temperature.

INTRODUCTION

Faba bean(*Vicia faba L*) is a significant crop worldwide, ranking fourth important grain pulse after dry beans, dry peas and chickpeas(Hawtin and Stewart, 1979) and second popular food legume in Europe(Pcard *et. al.*, 1988).the bean is a common breakfast meal in the Mediterranean region, Central and East Asia, and Ethiopia, and a familiar crop in the Americas and Oceania (Bond *et.al.*,1985). Broad beans are the most favored food legume in the Sudan (Salih and Ali, 1989).

World production has bean variable during the past 10 years ranging from a low of 3.58 million tons in 1997/98 to a high of 4.85 million tons in 2002/03, trending upward (FAO, 2004).

Faba bean requires a cool season for best development. it is grown in a winter, in wormer temperate and sup tropical areas; hardier cultivars in the Mediterranean regions tolerate winter temperatures of 10 ^{o} C without serious injury, whereas the hardiest European cultivars can tolerate up to -15C (Robertson,1996). It can be grown anywhere and does not winterkill. Suitable temperature requirement for growth ranges from 10 to 30 ^{o} C (Sexena,1979).Faba bean tolerates nearly any soil type, grows best on rich loams; requires adequate and sustained water supply (Duke, 1981 and Puresglove, 1984).

Corresponding Author: Ahmed Ali Mohammed Osman, Department of Agronomy, Faculty of Agricultural Studies, University of Sudan for Science and Technology, Shambat, Sudan, Box,72.

In the Sudan, faba bean is grown in the Northern and Nile States, where temperature are relatively cooler and winter longer; winters are shorter and worm southwards(Salih and Mohamed,1992).Moderate moisture supply is essential, with highest requirement at about 9-12 weeks after establishment(Duke,1981).

In Siliam, Northern region, Salih and Ali (1989) reported mean yield of 3.01 ton/ha (variety Sm-L), 2.556 ton/ha (variety H-72) and 2.356 ton/ha (local), whereas in Shambat. Salih(1994) recorded average yields of 3.742, 2.796 and 1.514 ton/ha for varieties BB.7 and H-72 and Sm-L, respectively. The yield differences were also noticed at El Rahad(Central Sudan) and New Halfa(East of Sudan) where yield were 2.719 ton/ha at the former location and 1.409 ton/ha at the latter site(Bashir,1983/84).

Under dry weather cropping as in Malakal (Southern Sudan), with very short cool season, three months with mean daily temperature of 28.5 ° C, no research work is available on faba bean cultivation. And no information available on the introduction of a faba bean cultivars to this new agro- ecological area. Therefore, this research was conducted to find the performance of three faba bean cultivars under Southern Sudan environment and compar the yield by different growning areas of faba bean with study area to determine the feasibility of growing faba bean for commercial production in this area as a new agro-ecological crop.

MATERIALS AND METHODS

2.1 Location:

Field experiments were carried out in two consecutive seasons (2004\05 and 2005/06)in the Main Campus Farm of the Upper Nile University "Malakal". Malakal is located on Latitude 09 ° 33" N and Longitude 32 ° 39" E at altitude 390m. The climate is described as Savanna, with six months rainy season, from May to October. The cool Weather begins in November and ends in January, with average maximum temperature of 36.8oc and the mean minimum of 20 ° C during the winter months and relative humidity of around 30 %(Table 1). The soil was sandy clay, with quite high permeability, apparent density 1.8g/cm2, pH 6.84.

Table 1: Metrological data for Malakal for two experimenting seasons.

Month	Temperature (˚C)						Relative humidity (%)		Rainfall (mm)	
	Mean max		Main min		Mean daily					
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06
October	34.9	34.4	23.0	22.4	28.95	28.4	73	75	45.6	85.1
November	37.0	36.2	21.7	19.4	29.95	27.8	51	49	TR	0
December	36.3	38.1	20.2	19.3	28.25	28.7	30	36	0	0
January	35.7	38.0	19.1	20.5	27.4	29.25	21	30	0	0
February	41.1	39.8	23.2	19.6	32.15	29.7	21	22	0	0
Mean	**37.0**	**37.3**	21.44	20.24	29.22	28.77				

SMA(2004/05 -2005/06)

2.2 Experimental Design and Treatments:

Treatment consisted of three faba bean cultivars, namely, H-93, BB-7 and Sm-L. The seed material was obtained from Hudeiba Agricultural Research Station, El Damer(Northern Sudan). The layout followed was randomized complete block design with three replications. The land was ploughed, harrowed, leveled and ridged. Divided into nine plots each measuring 320x320cm. Ridge spacing of 80 cm apart.

First season (2004/05) sowing was on first day of November, irrigation interval was 7 days, and the second season (2005/06) planting was on 15 October with watering intervals of 3 days. Two seeds were sown per hole spacing of 15cm on a ridge. No insect pests control applied or fertilization during the first season. Top dressing with urea was applied 43 days after emergence when the crop showed leaves yellowing and bean aphids controled with Malathion during the same period.

2.3 Parameters Measures:

The following parameters were measured for two consecutive seasons; plant height (cm), ten plants were randomly selected from each replicate and their height were measured from the tip to the ground level. Number of branches per plant, number of nodes per main stem, number of podded nodes per stem and after full maturity was attained, yield and yield components were recorded by harvesting the selected plants, and then numbers of pods per plant, number of seeds per pod, number of seed per plant were calculated. Total weight of the whole plant cut from the ground to determine the total dry matter. Threshing and weighting the seeds produced by a plant contain seed yield per plant.1000 seeds weight was recorded from the weight of 1000-seeds of bulk seeds of plant sampled. Yield per hectare was obtained by threshing and weigh ting the seed of plot and geting the mean of three plots.

2.4 Statistical Analysis:

Data generated was subjected to Statistical Package for Social Science (SPSS). Means were tested using two factors randomized complete block design, where factor A represents varieties(3) and factor B represents season(two) and then mean separated using Dunkann s Multiple Range Test(DMRT) according to Steel and Torrie(1980).

RESULTS AND DISCUSSION

3.1 metrological data for various faba bean production locations in the Sudan are compared with that of Malakal area. Temperature during the winter seasons of 2004/05 and 2005/06 were shown in Table 2. Comparison of temperature of Malakal with various faba bean areas of production in Sudan namely Hudeiba, Shambat, and Wad Madania reported that the mean max temperature was 32.9,33.7 and 35.3 respectively for the three locations and for Malakal was37.2. The mean min was 17.9, 18.2, 18.1, and 20.8, and the mean daily temperature was 25.4, 25.9, 26.7 and 29.0 for the four locations respectively. As general the observation showed that there were slight deviations of temperature in the Malakal location compared with the other locations.

Table 2: metrological data for various faba bean production locations in the Sudan(1981/82 season) compared with Malakal area temperature during the winter seasons of 2004/05 and 2005/06

Location month	Temperature											
	Hudeiba			Shambat			Wad Madani			Malakal		
	Mean max	Mean min	Mean daily	Mean max	Mean min	Mean daily	Mean max	Mean min	Mean daily	Mean max	Mean min	Mean daily
October	39.6	25.4	32.5	39.9	24.8	32.4	38.6	22.5	30.6	34.7	22.7	28.7
November	33.6	19.0	26.3	33.8	19.7	26.8	35.6	18.7	27.2	36.6	20.6	28.6
December	32.7	17.9	25.3	33.6	17.6	25.6	35.1	17.5	26.3	37.2	19.8	28.5
January	30.3	15.5	22.9	32.0	15.4	23.7	34.0	16.6	25.3	36.8	19.8	27.7
February	28.4	11.7	20.1	29.1	13.3	21.2	33.0	15.2	24.1	40.4	21.4	30.6
Mean	**32.9**	**17.9**	**25.4**	**33.7**	**18.2**	**25.9**	**35.3**	**18.1**	**26.7**	**37.2**	**20.8**	**29.0**

3.2Growth Attributes:

The effect of Malakal environment on growth of three cultivars of faba bean was showed for two seasons (2004/05and 2005/06) in the Table2. The results indicated that the growth of three cultivars increased from first season than the second season for all growth attributes (plant height, number of branches, number of nodes per plant, total dry matter production and number of podded nodes per plant).

Plant Height:

In both seasons plant height showed no significant differences among the three cultivars, but H-93 revealed the highest plants (72.7 cm).

Number of Branches per Plant:

The effect of Malakal environment on number of branches per plant indicated no significant difference in the first season and highly significant difference in the second season. BB-7 showed the highest values which was 4.4.

Number of Nodes per Plant:

This character also showed no variation among cultivars in the first season. Furthermore highly significant difference was observed in the second season and H-93 cultivar gave the greatest value which was 38.3.

Total Dry Matter Production:

A highly significant difference was observed in the second season but there were no significant difference in the first season. Meanwhile for the two seasons H-93 cultivar showed higher values 11.59 and 24.29 for first and second season respectively.

Number of Podded Node per Plant:

Number of podded nodes per plants resulted in highly significant differences at (p=0.05) for both seasons. H-93 represented the higher values among other cultivars. 5.0 and 10.3 for 2004/05 and 2005/06 respectively.

Table 3: Growth attributes of three faba bean cultivars grown under Malakal environment in two seasons 2004/05 and 2005/06

Variety	Plant height		Numbers of branches		numbers of nodes /plant		Total dry matter production		Number of podded nodes /plant	
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06
H-93	50.03 a	72.70 a	1.96 a	3.23 b	27.87 a	38.33 a	11.59 a	24.29 a	5.0 a	10.3 a
BB-7	50.70 a	62.67a	1.70a	4.43a	27.87a	34.17ab	8.76 a	18.58b	2.9b	7.96ab
Sm-L	48.07 a	63.00 a	1.96 a	3.53 b	27.77 a	33.00 b	7.74 a	20.08 ab	2.2	7.46 b
CV%	2.5	36.0	18.07	11.15	1.31	6.37	18.07	10.85	26.59	13.8
LSD0.05	2.81	47.97	0.68	0.94	0.82	5.07	3.82	5.16	2.02	2.6

Any two mean values having different superscript letters differ significantly at (P=0.05)

3.3. Yield related traits of the three faba bean cultivars grown under Malakal environment in two seasons 2004/05 and 2005/06 were presented in Table 4. The results indicated that seed yield and number of pods per plant increased in the second season than first season. But 100 seed weight and number of seeds per pod remain stable among different cultivars for the two seasons.

Number of seeds per plant resulted in significant difference at (P=0.05)in the second season for H-93 which was 8.7. But there was no significant difference in the second season. On the other hand H-93 cultivar reflected the highest values among the tested cultivars 21.3.

Number of pods per plant, it revealed highly significant difference for the two seasons and H-93 cultivar indicated the greatest value 5.0 and 11.2 for the first and second season respectively.

1000 seed weight and number of seeds per pod showed no significant difference among cultivars for two seasons.

Table 4: yield related attributes of three faba bean cultivars grown under Malakal environment in two seasons 2004/05 and 2005/06

Variety	Number of seeds/ plant		numbers of pods/plant		1000 seed weight		Number of seeds /pod	
	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06	2004/05	2005/06
H-93	8.7 a	21.3 a	5.0 a	11.2 a	31.7 a	39.0 a	1.7 a	1.9 a
BB-7	5,1b	16.8a	2.9b	9.1b	30.9a	38.4a	1.5a	2.8a
Sm-L	3.1 b	17.23 a	2.2 b	9.1 b	33.7 a	35.9 a	1.3 a	1.9 a
CV%	22.98	13.53	26.15	9.19	7.94	4.9	26.4	11.2
LSD0.05	2.92	5.6	1.99	2.04	57.89	1.08	0.89	0.47Any two

mean values having different superscript letters differ significantly (<=0.05)

3.4 Wide ange of variation was evident between the analyzed interaction of two seasons. Results was presented in Table 5. There was clear fluctuation in yield, number of pods and number of seeds per plant. The results indicated highly significant differences between the two seasons among cultivars. The Second showed clear increas in productivity. While the yield was low in the first season. Yield increased from (490 kg/ha) in the first season to (1366.8 kg/ha) in the second.

Table 5: interaction analysis between the two seasons for yield, number of pods per plant and number of seed per plant.

	Yield kg/ha	Number of pods plant	Number of seed / plant
		2004/05	
Means	302.3 b	3.4 b	5.6
		2005/06	
Means	1252.1a	9.8 a	18.44a
Lsd 0.05		1.627	3.435
CV %	15.32	13.59	15.69

3.5 When Malakal grown cultivars were compared with other faba bean production areas in four locations in Sudan it was evident that there was remarkable variation in productivity among different cultivars for these locations. (Table 6). As general different cultivars among other location showed high grain yield productions area gives more grain yield than when the same cultivars grown in Malakal. But 1000 seed weight (g) showed no great variation among different cultivars and different locations. BB-7, Sm-L and H-93 cultivars revealed higher productivity (2742, 3005 and 2556 respectively for the average of 4 locations while their productivity in Malakal location was sharply declined to 702.3, 641.1 and 928.6 respectively. The number of pods per plant showed similar Trend.

Table 6: Malakal grown cultivars relative to other faba bean production location in Sudan.

Cultivar	National Verification trial (average of 4 locations)			Malakal location (2004/2006)		
	Yield (kg/ha)	No. of pods per plant	1000 – seed weight (g)	Yield (kg/ha)	No. of pods per plant	1000 – seed weight (g)
BB-7	2742	20.1	384	702.3	6.0	346.8
Sm-L	3005	------	549	741.1	5.8	397.7
H-72	2556	18.7	409	------	-----	-----
H-93	-----	------	------	928.6	8.6	351.3
Shambat 616	3138	17.8	442	------	-----	-----

Discussion:

Reduced growth, yield and yield related components values of faba bean grown in Malakal area (Table3 and 4) were attributed to the short growing season (Table3). Suitable production temperature for faba bean range from 10-30 ^{o} C (Sexena, 1979). On the other hand, (Duke, 1981), reported that the optimum temperature of faba bean is 18-27 ^{o} C. Meanwhile, Evans (1959) found that constant temperature above 23 C can inhibit flowering. The main constrain in Malakal environment was high temperature (Table 2). Which was very high compared with the main areas of faba bean production in other locations in Sudan. Moisture deficit may have also affected the crop performance during the growing seasons in Malakal.

Factor which suppressed normal plants growth was enhanced tendency to develop senescence. The stressed crop, as observed by dwarf stature(plant height of 48.07cm) that feature season 2004/05 had shortened the flowering time and hastened ripening and ultimately reproductive component development and functional life duration. Similar finding were reported by (Salem, 1969) and Badr *et.al*.,1976). While in the second season (2005/06) when the growing season was lengthened by 15 days advanced sowing, coupled with reduction in watering interval the mean plant height increased to 72.7 cm (Table3). There was also substantial increase in other growth, yield and yield component (Table3 and 4) also it is clear in combination analysis between the two seasons (Table5)

This finding were corresponding with Salih and Ageeb, 1988; Ageeb, *et. al*., (1989) who reported that appropriate planting times is important in regions with short winters. The timing enables the crop to have full benefit of the favorable growing conditions, and secondly, differences in temperature requirements between existing cultivars may be used to select early flowering and maturing cultivars tolerant to warm conditions (Salih, 1994).

High temperature during flowering period cause flower shedding and immature pods dropping as well as stopping more flower and pod sets and subsequently production of fewer pods per plant (Hassan, 1984, Ageeb, 1981 and Mohamed,1986).Also this finding was agreed with (Jones, 1963) who found that yield of faba bean depended on the rapid growth before flowering began to develop. The date at which the first flower buds appear or first open were found to be controlled by long- day condition (photoperiod) (Summerfield, 1983 and Sexena, 1982). Favorable growing effect on crop phenology was to increase the length of flowering and pod set stage ie. Reproductive stage (Ahmed, 2002). Associated with unfavorable growth condition at some stage of growing periods , where by plant produce short inter nodes , and some plant may have failed to develop nodes capable of producing flowers. Number of seeds per pod and 100 seed weight in both season indicated that the environments did not significantly affect this traits. It is relatively stable character (Kambal, 1968)

The results indicated that genotype have variation in respect to tolerance to environmental condition (adaptation) (Table 5). This finding was confirmed by (Bond, *et.al.*, 1984 El Sheld, *et. al*., 2002).

In general all growth and yield results reflected that Sm-L cultivars failed to exploit this environment. And this was agreed with (Salih and Ali, 1989) who reported that Sm-L cultivar was adapted to the cooler and winter of Northern Sudan, where its average yield reached 3005 kg/ha (Table 6) Salih, 1992 and Salih, 1989). In contrast to the above findings (Salih and Bushra, 1987) recorded that Sm-L cultivar has higher auto-fertility index, which is important under dry weather conditions prevailing in the Sudan where insect pollinators are rare.

Recommendations:

From the above results and discussion, commercial faba bean production may not be feasible in Malakal area in the near future, due to the short growing season and lack of suitable cultivars for the tested environment.

H-93 and BB-7 cultivars reflected good prospects for substantial growth and yields. And finally variations among two seasons encourage more research for appropriate sowing date and optimum watering interval.

REFERENCES

Ageeb, O.A.A., 1979. The effect of sowing date and watering interval on the grain yield of broad bean. Hudeiba Agric. Research. Station. In: *Fabis Newsletter*., pp: 22-23.

Ageeb, O.A.A., G.E. Mohamed, M.E.K. Ali, F.A. Salih and S.H. Salih, 1989. Evaluation of promising faba bean genotypes for seed yield and resistance to disease in the traditional areas (season 1988/1989). Annual Coordination Meeting 4-7 Sept. 1989). Nile Valley Regional Program in Cool Season Legumes, Wad Madani, Sudan.

Ahmed, I.D.Y., 2002. Effect of water stress at different growth stages on growth and productivity of faba bean (*Vicia faba* L.). M.Sc. Thesis, Faculty of Agric. University of Khartoum, Sudan.

Badr, M.A., El Din, N.A.N. and A.M. Abdel Gawad, 1976. Horse bean plant as affected by some agricultural practies. *Field crops*: Abstract., 29: 347.

Bashir, M., 1983/1984. Faba bean agronomy for new areas: response of faba bean to sowing date at El Rahid. ICARDA/ IFD Nile Valley Project on faba bean.

Bond, D.A., D.A. Lawes, G.C. Hawtin, M.C. Sexena and J.S. Stephens, 1985. Faba bean (*Vicia faba* .L)P.199-265. in R.J., Summerfield and E.H., Roberts(eds.).Grain Legumes Crops.William Collins Sons Co.Ltd.8 Grafic street, London WIX 3LA,UK.

Ducke, J.A., 1981. Handbook of legumes of world economic importance Plenum Press, New York, pp: 199-265.

FAO, 2004. Statistical Yearbook. Vol. no. 2, Rome, Italiy.

Hassan, M.S., 1984. Introduction of broad beans (*Vicia faba L*) into the central clay plains of the Sudan. *Acta Hort*., 19:199-207.

Hawatin, G. and R. Stewart, 1979. The development, production and problems of faba bean (*Vicia faba* L.) in West Asia and North *Africa.Fabis Newsletter*., 1: 7-9.

Jones, L.H., 1963. The effect of soil moisture gradient on the growth and development of broad beans(*Vicia faba*. L). *Hort. Res. Edin*., 3: 13-26.

Kambal, A.E., 1968 . A study of agronomic characters of some varieties of (*Vicia faba L*.). *Journal of Agric. Sci*., 72: 359-363.(Cambridge).

Mohamed, M.B., 1986. Response of faba bean to sowing date at El Rahad, Sudan, Rahad Research Station, Elfau, Sudan. In: *Fabis Newsletter*., pp: 14.

Picard, J.J,. D.A. Bond, L. Monti and R. Steuckardt, 1988. Production of pea, faba bean and chickpea in Europe.1065-1080. in : R.J. Summerfield (ed.). World Crops : cool season food legumes Kluwer Publishers, Dordrecht, the Netherlands.

Purseglove, J.W., 1984. Tropical crops: Dicotyledons. Longman Group Ltd., London House, Burnt Mill, Harlow Essex, England.

Robertson, L.D., 1996. Useful genetic diversity in germplasm collections of food and forage legumes from West Asia and North Africa. Germplam Resources and Crop Revolution, 43: 447-460. Kluwer Academic Publishers, Dordrecht, the Netherlands.

Salih, F.A., 1992. Shambat 104, a new faba bean cultivar for the Gezira, Sudan. *Fabis Newsletter*., 30: 1992.

Salih, H.S. and A.E. Ali, 1989. A new faba bean cultivar for the Northern Province of the Sudan. *Fabis news letter*., April.

Salih, F.A. and A.G. Bushara, 1987. Studies of out- crossing and autofertility. Pages 42-43 in the sevenths Annual Coordination Meeting of ICARDA/IFAD Nile Valley Project 23-27 sept. 1986. Addis Ababa, Ethiopia ICARDA, Aleppo, Syria.

Salih, F.A. and M.B. Mohamed, 1992. Shambat 75, a faba bean cultivar for El Rahad area of Sudan. In ;*Fabis Newslettr*., 30: 17-19.

Saxena, M.C., 1979. Agronomical and physiological aspects of some important food legume important and development(G. C. Hawtin and G.J. Chancellor, eds) Ottawa IDRC., pp: 155-156.

Steel, R.G.D. and J.H. Torie, 1980. Principles and Procedures of Statistics . Published by McGRAW-HILL BOOK COMPANY, INC.New York.

SMA, 2004. Sudan Metrological Authority, Administration of Data Services, Khartoum.

SMA, 2005. Sudan Metrological Authority, Administration of Data Services, Khartoum.

Summerfield, R.J. and E.H. Roberts, 1983. Environmental regulation of flowering in faba bean, chickpeas and lentils. In: " Poceeding of the international Workshop on faba beans, Kabuli, Chicpeas and lentils in 1980. Allepo, Syria .ICARDA, 1983 (in: King Saud University Journal vol.5 *Agric. Sci*., (2): 189-208.