Annals of Plant and Soil Research 16(2): 139-142 (2014)

EFFECT OF FERTILITY LEVELS, FARMYARD MANURE AND IOINOCULANTS ON GROWTH, YIELD AND UPTAKE OF NUTRIENTS BY SORGHUM

B.B. KUSHWAHA, N.S. THAKUR, USHA SAXENA, D.K. SHRIVASTAVA, V.P. KATARIA, S.N. UPADHYAY AND R.K. CHOUDHARY

All India Coordinated Sorghum Improvement Project, College of Agriculture, Indore, M.P. 452001, INDIA
Recived: Febuary, 2014; Revised accepted: MAY, 2014

ABSTRACT

A field experiment was conducted during rainy seasons (Kharif 2008 and 2009) to assess the effect of fertility, farmyard manure and bioinoculants on the productivity of sorghum [Sorghum bicolor (L.) Moench]. Application of 100% RDF enhanced 50% flowering as well as improved various growth attributes viz. plant height, dry matter accumulation (DMA), and leaf area over 75 and 50% RDF. Grain yield was significantly improved by 100% RDF showing an increase of 14.5% and 36.6% and dry fodder 10.9% and 20.6% over 75% RDF and 50% RDF, respectively. Application of 100% RDF was also recorded significantly higher nutrient uptake and economics as compared to 75% and 50% RDF during both the years. Application of 10 t FYM ha^{-1} significantly increased plant height, leaf area dry matter g/plant, grain yield, dry fodder yield, economics and nutrient uptake by sorghum over no FYM. Inoculation of PSB, Azospirillum and in combination with PSB + Azospirillum increased grain yield upto an extent of 3 to 7%. Bio inoculants i.e. PSB + Azospirillum significantly increased grain yield, nutrient uptake and returns/ profits of sorghum over their individual effect.

Key words: FYM, Fertility, *Azospirillum*, *PSB*, Sorghum

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the major staple food crops of millions of people in semi arid tropics. It is considered as the king of millets and extensively grown in Africa, China and India. Sorghum is an exhaustive crop and responds well upto 120 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}. Nutrient requirement further increased with the use of high yielding hybrids. Integrated use of different sources of plant nutrients such as organic manure and bioinoculants in combination with chemical fertilizers improve soil fertility and crop yield (Ghosh 2003). Therefore, the present investigation was conducted to find out the effectiveness of organic manure and bioinoculants i.e. phosphate-solubilizing bacteria, *Azospirillum* in combination with chemical fertilizers on growth and yield under prevailing agro climatic condition of Malwa plateau in Madhya Pradesh.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season of 2008 and 2009 at College of Agriculture Indore, Madhya Pradesh The soil of the experimental plot was clay in texture having fairly high moisture retention capacity, organic carbon (4.5 g kg^{-1}) available nitrogen (200 kg ha^{-1}), phosphorus (9.6 kg ha^{-1}) and potassium (497 kg ha^{-1}) with pH 7.9. The treatment consisted of 3 levels of fertility (100% RDF as 80 kg N + 40 kg P_2O_5 + 40 kg K_2O ha $^{-1}$, 75% RDF and 50% RDF), 2 levels of farmyard manure (0 and 10 t ha^{-1}) and bioinoculants (control, phosphate, solubilizing bacteria (*PSB*), *Azospirillum* and *PSB* + *Azospirillum* coinoculation. The fertilizer sources of NPK were urea, single superphosphate and muriate of potash. These treatments were evaluated in split plot design (3 levels of Fertility + 2 levels of farmyard manure in the main plot and bioinoculants in the sub plot) with three replications. Sorghum hybrid, CSH 16 was sown on 26 June, 2008 and 20 June, 2009 in furrows at 45 cm. row spacing using a seed rate of 10 kg ha^{-1}. The crop was harvested on 23 October, 2008 and 20 October, 2009. Total amount of rainfall during the crop growth period was 588.6 mm and 1017.0 mm in 2008 and 2009 respectively. Observations were recorded on leaves per plant, plant height, dry matter (g per plant), days to 50% flowering, grain yield, dry fodder yield, economics. The N, P and K content in plants were analysed by adopting standard procedures (Jackson, 1973).

RESULTS AND DISCUSSION

Fertility levels

Leaf area, plant height and dry matter (g/plant) of sorghum were significantly improved with successive increase in fertility levels upto 100% RDF (Table 1) which may be attributed to expanded leaf area, plant height and dry matter as a result of increased cell division and enlargement due to the N, P and K nutrition. Plant height, dry matter accumulation and leaf area showed a significant improvement upto 75% RDF accounting to an increase of 5.5, 9.5 and 15.6%, respectively over 50% RDF. Fertility levels caused

Table 1: Effect of fertility, farmyard manure and bioinoculants on yield, returns and B:C ratio of sorghum (pooled data of 2 years)

Treatment	Plant height (cm)	Leaf-area (cm^2)	Dry matter (g/plant)	Days to 50% flowering	Grain yield (q ha^{-1})	Dry fodder yield (q ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C Ratio
Fertility level									
100% RDF	212.07	3910	86.93	69.27	45.49	130.15	32845	21225	2.94
75% RDF	199.88	3514	78.51	70.00	39.71	117.28	28135	16969	2.64
50% RDF	189.38	3039	71.72	72.04	33.29	107.83	24185	13464	2.37
CD (P=0.05)	3.21	99.49	3.50	0.23	2.08	5.13	1134	1134	0.09
FYM t ha^{-}									
0	198.24	3429.39	76.89	70.43	38.23	115.20	27480	18810	3.15
10	202.65	3587	81.21	70.44	40.76	121.64	29298	15628	2.13
CD (P=0.05)	2.62	81.24	2.89	N.S.	1.71	4.18	926	926	0.07
Bioinoculants									
Control	198.80	34.18	75.89	70.59	38.17	113.60	27614	16454	2.58
PSB	200.00	3520	78.66	70.44	39.18	118.26	28152	16982	2.62
Azospirillum	200.65	3438	80.03	70.38	39.59	119.42	28341	17171	2.64
PSB+Azospirillum	200.32	3656	81.64	70.38	41.03	122.40	29448	18269	2.74
CD (P=0.05)	N.S.	63.32	3.39	N.S.	1.97	4.86	1028	1028	0.09

significant effect on days to 50% flowering, whereas in plants with 75% and 100% RDF attained early flowering compared to the 50% RDF. Data indicated that 100% RDF and 75% RDF reduced the duration of 50% flowering by 2 and 3 days as compared with the 50% RDF (Singh and Surneriya, 2012).

The improvement in growth as well as photosynthetic parameters (leaf area) due to fertilizer application might have resulted in better interception and utilization of radiant energy leading towards higher photosynthesis and finally more accumulation of dry matter by individual plant. Fertility level (100% RDF) significantly stepped up grain yield by 19, 36.6 and dry fodder 8.7, 20.7% over 75% and 50% RDF, respectively. The highest gross return was recorded under higher fertility. It was higher by 16.7 % and 35.8 % than 75 and 50% fertility levels.Net return increased with increasing level of fertility. The highest net returns of Rs. 21225 ha^{-1} were recorded with highest level of fertility application. Medium fertility level (75%RDF) was also superior to lower fertility level (50%). Similar findings were also reported by Parasuraman *et al.* (2000) and Singh *et al.* (2012). Significantly highest B:C ratio was recorded (2.94) under higher level of fertility than medium and lower fertility levels. Significantly higher uptake of nitrogen of 88.3 kg ha^{-1} in sorghum grain and 119.3 kg ha^{-1} in sorghum dry fodder were obtained at higher level of fertility and these were higher by 27.8 and 59.3 percen% in sorghum grain and 17.4 and 30.4 % in sorghum dry fodder over medium and lower level of fertility. These results are in agreement with results obtained by Ram and Singh. (2003). The application of higher level of fertility gave significantly higher uptake of phosphorus in sorghum grain and it was higher by 21.8 and 52.3 % over medium and lower level of fertility, respectively (Table 2). The corresponding increases in P uptake by fodder were 25.7 and 50.2 percent. The significantly higher potassium uptake in sorghum grain and dry fodder was recorded under higher level of fertility. It was higher by 22.4 and 56.0 % and 17.0 and 39.4 % over medium and lower level of fertility, respectively. Increasing levels of fertilizer application increased the N, P and K uptake as reported Verma *et al.* (2005) and Singh *et al.* (2012).

Farmyard manure

Plants under the influence of 10 t FYM ha^{-1} application significantly attained higher plant height, leaf area, dry matter accumulation than without FYM (Table 1) .Incorporation of FYM resulted in improvement of soil physical properties and also increased organic carbon available P and K status of soil (Gawal and Pawar 2006). Application of 10 t FYM ha^{-1} also registered a yield advantage of 2.53 quintal grain and 6.44 quintal dry fodder ha^{-1}compared to no FYM (Table 1). Application of 10 t FYM ha^{-1} gave significantly higher gross return and it was higher by 6.0% over no FYM. Among the FYM levels, no FYM significantly increased the net return and these were higher over 10 t FYM ha^{-1} by 3182 Rs ha^{-1}. Similar findings were also reported by Gautam *et al.* (2001). No FYM recorded significantly higher cost benefit ratio of (3.15) over 10 t FYM ha^{-1}.

Significantly higher uptake of nitrogen was recorded under 10 t FYM ha^{-1}. It was 74.2 kg ha^{-1} in grain and 107.5 kg ha^{-1} in sorghum dry fodder and higher by 9.6 % in sorghum grain and 6.7 % in sorghum dry fodder over no application of FYM. The maximum value of phosphorus uptake in sorghum grain and fodder was recorded with 10 t FYM ha^{-1} which was 9.7 and 10.1 % higher over control. A higher uptake of potassium in sorghum grain and dry fodder was observed under 10 t FYM ha^{-1} and it was higher by 9.3 and 7.3 % over no FYM, respectively.

Table 2: Nutrient uptake of sorghum as influenced by fertility levels, FYM and bioinoculants (Pooled data of 2 years)

Treatment	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium(kg/ha)	
	Grain	Dry Fodder	Grain	Dry Fodder	Grain	Dry Fodder
Fertility level						
100% RDF	88.3	119.3	21.5	18.8	74.7	231.5
75% RDF	69.1	101.5	17.6	14.9	61.3	197.9
50% RDF	55.4	91.4	14.1	12.5	47.9	166.0
CD (P=0.05)	6.6	4.4	0.9	0.8	3.3	8.7
FYM (t ha^{-1})						
0	67.6	100.6	16.9	14.7	58.5	191.4
10	74.2	107.5	18.6	16.2	63.9	205.5
CD (P=0.05)	2.9	3.6	0.8	0.6	2.7	7.1
Bioinoculants						
Control	67.9	99.3	16.9	14.5	58.5	189.1
PSB	70.4	103.8	17.6	15.4	60.9	198.4
Azospirillum	71.1	105.1	17.7	15.5	61.2	199.6
PSB+Azospirillum	74.2	108.0	18.7	16.4	64.3	206.7
CD (P=0.05)	3.7	4.3	0.9	0.6	3.2	8.4

Bioinoculants

Co inoculation of *PSB* + *Azospirillum* significantly increased leaf area, dry matter accumulation over the control. Single inoculation of *PSB* increased the leaf area over control. However, bioinoculants did not show significant effect on plant height, days to 50% flowering. *Azospirillum* inoculation resulted in significantly higher dry matter per plant over control and it was found at par with dual inoculation. The beneficial effect of *Azospirillum* on dry matter production was also reported by Gawal and Pawar (2006). Coinoculation of *PSB* with *Azospirillum* significantly increased grain and dry fodder yield by 7.4 and 7.7 % over control. Application of bio-inoculants (PSB + *Azospirillum*) gave higher gross returns over no inoculation, *PSB* and *Azospirillum*. The highest net returns of Rs. 18269 ha^{-1} was recorded under *PSB*+ *Azospirillum* inoculation than control. Co inoculation of *PSB* + *Azospirillum* was recorded significantly lower B: C ratio over no inoculation, *PSB and Azospirillum* coinoculation gave the highest uptake of 74.2 kg ha^{-1} in sorghum grain and 108.0 kg ha^{-1} in sorghum dry fodder. These were 9.2, 5.3 and 4.3 % higher in grain sorghum and 8.7, 3.9 and 2.8 % higher in dry fodder over without inoculation of PSB and *Azospirillum* respectively (Table 2). Co inoculation of *PSB +Azospirillum* gave the higher uptake of phosphorus in sorghum grain by 10.8, 6.2 and 5.4% than no inoculation, *PSB* and *Azospirillum* respectively. The corresponding increases in P uptake by fodder were 13.0, 6.6 and 5.7 %. Similar trend was recorded for phosphorus uptake by sorghum straw. Significantly higher potassium uptake in sorghum grain and dry fodder were recorded under *PSB +Azospirillum* co inoculation and it was higher 9.83, 5.41 and 5.08 % and 9.37, 4.20 and 3.60 % over no inoculation *PSB* and *Azospirillum* respectively (Table2) Similar findings were also reported by Parasuraman *et al.* (2000).The existence of favourable, nutritional environment under the influence of bioinoculants had a positive influence on vegetative and reproductive growth, which ultimately led to realization of higher dry fodder yield. Further dual inoculation of PSB and *Azospirillum* showed beneficial effect on plant growth and productivity, indicating a positive interaction between two groups of organisms (Patidar et.al. 2004).

It is concluded from the results that 25% of fertilizers may be saved. Application of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O_5 ha^{-1} along with 10 t FYM ha^{-1} and inoculation of PSB and *Azospirillum* can safely be recommended for higher yield of sorghum.

REFERENCES

Gautam, V.S., Kushwaha B.B, Nayak, Siddarth and Kushwaha, S.S. (2001) Integrated nutrient management for kharif sorghum. Indian *Journal of Dryland Agricultural Research & Development.***16**: 83-85.

Gawal, P.P. and V.S. Pawar (2006) Integrated nutrient management in sorghum (sorghum-bicolor)-chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. *Indian Journal of Agronomy* **50**:17-18.

Ghosh, P.K. , Bandyopadhyay , Tripathi , A.K. , Hati , K.M. , Mandal ,K.G. and Mishra , A.K. (2003) Effect of integrated management of farmyard manure, phosphocompost, poultry manure and inorganic fertilizer for rain fed sorghum (*sorghum bicolor*) in vertisol of central India. *Indian Journal of Agronomy* **48:** 48-52.

Jackson, M.L. (1973) *Soil Chemical Analysis*, Prentice Hall of India Private Limited, New Delhi.

Parasuraman, P., Duraisamy, P. and Mani, A.K. (2000) Effect of organic, inorganic and biofertilizers on soil fertility under double cropping system in rainfed red soils. *Indian journal of Agronomy* **45:** 242-247.

Patidar, M. and Mali, A.L. (2004) Effect of farmyard manure, fertility levels and bio-fertilizers on growth, yield and quality of sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy* **49**: 117-120.

Ram, S.N. and Bhagwan Singh (2003) Physiological growth parameter , forage yield and nitrogen uptake of sorghum (Sorghum bicolor) as influenced with legume intercropping, harvesting time and nitrogen levels. *Indian Journal of Agronomy* **48:** 38-41.

Singh, P. and Sumeriya, H.K (2012) Effect of nitrogen on yield, economics and quality of fodder sorghum genotypes. *Annals of Plant and Soil Research* 14(2): 133-135.

Singh, P. and Sumeriya, H.K., Solanki, N.S. and Murdia, A. (2012) Productivity, economics and quality of fodder sorghum under varying levels of nitrogen and phosphorus. Annals of Plant and Soil Research 14(2): 127-129.

Verma, S.S., Singh, N.Joshi, Y.P.and Deorari, V. (2005) Effect of nitrogen and zinc on growth characters, herbage yield, nutrient uptake and quality of fodder sorghum (*sorghum bicolor*). *Indian Journal of Agronomy* **50**(2):167-169.