Madras Agric. J. 89 (4-6) : 245-248 April-June 2002
https://doi.org/10.29321/MAJ.10.A00210

Response of sorghum based cropping system to nitrogen and phosphorus in rainfed vertisols

K.R. LATHA, P. JAYAPAUL AND R. DURAI SINGH
Dept. of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu.

Abstract: **Field experiments under rainfed vertisols were conducted at the Regional Research Station, Aruppukkotai, Tamil Nadu, India in rainy seasons (Sep-Jan) of 1994-95, 1995-96 and 1996-97. Treatments consisted of 3 cropping systems and 4 levels of each N and P. The grain and straw yield of sorghum was higher when grown as sole crop. The response of component crops (cowpea and pearlmillet) to applied fertilizers were almost linear. Further application of N and P to sorghum did not show any adverse effect on the performance of intercrops. The yield of component crops were higher in normal rainfall years and were reduced in the low rainfall year. Pearlmillet was a better inter crop with sorghum than cowpea during low rainfall year.**

Key words: Sorghum, Cowpea, Pearlmillet, Nitrogen, Phosphorus, Rainfed, Vertisol.

Introduction

Intercropping has been recognised as a potential system for augmenting the productivity of drylands over space and time in subsistence farming situations. Hall (1978) claims that heavy fertilization regimes may not allow species in a mixture to express their potential complementarity in the use of resources. The effect of nitrogen and phosphorus on dry matter and seed productivity can be investigated by using 'replacement' principle in cowpea and maize intercrops (Hall 1974). The information on the fertilizer recommendations for sole crops are available in plenty and such information for an intercropping system having crops of diverse nutrient requirements are meager. Therefore, the response of sorghum based cropping system to applied nitrogen and phosphorus was studied under rainfed vertisols of south zone of Tamil Nadu.

Materials and Methods

Field experiments were conducted during the *rabi* seasons (Sep-Jan) of 1994-'95, 1995-'96 and 1996-'97 in rainfed vertisols at Regional Research Station, Aruppukottai. Three cropping systems (sorghum + cowpea, sorghum + pearlmillet and sole sorghum) and four levels of fertilizers (0:0, 40:20, 60:30 and 80:40 kg $N:P_2O_5$ ha^{-1}) were tested in factorial randomised blocks design with three replications. The soils of the experimental sites were medium deep vertisols, low in available nitrogen (149.8 to 162.5 kg ha^{-1}) and phosphorus (4.9 to 6.2 kg ha^{-1}) and high in available potassimn (410-416 kg ha^{-1}). A total quantity of 503.7, 565.9 and 185.5 mm of rainfall were received in 29, 29 and 18 rainy days, respectively during the cropping seasons of 1994-'95, 1995-'96 and 1996-'97. Half the dose of N and full dose of P_2O_5 were applied as basal to the crop rows at sowing and the remaining N was top dressed after 30 days of basal application on receipt of sufficient rains in all the three years.

Seeds were sown in already formed compartmental bunds in lines spaced at 45 cm in replacement series. Every third row of maincrop was replaced by one row of intercrop. The intra row spacing was 15, 10 and 15 cm for sorghum, cowpea and pearlmillet, respectively. Sowings were done on 18.9.1994, 18.9.1995 and 24.9.1996 on receipt of rains. Harvesting was done at maturity of the crops. The yield of component crops were recorded and expressed in kg ha^{-1}.

Results and Discussion

Grain yield of sorghum (Table 1)

The sorghum grain yield was higher when grown as sole crop. The grain yield was reduced due to intercropping. During first year, sorghum yield was significantly higher (2745 kg ha^{-1}) when grown as sole crop. Intercropping sorghum with either cowpea or pearlmillet resulted in lesser grain yield of sorghum.The grain yield of sorghum ranged from 2251 to 2489 kg ha^{-1} under different treatments. The lowest grain yield of sorghum (2251 kg ha^{-1}) was observed when intercropped with pearlmillet. Similar trend was noticed during second year also. However, during third year, the sole sorghum yield was comparable with sorghum yield in sorghum + cowpea system (1096 kg ha^{-1}), but in turn it was on par with sorghum

Table 1. Effect of cropping systems and fertilizer levels on the yield of sorghum

Treatment	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	1994-'95	1995-'96	1996-'97	1994-'95	1995-'96	1996-'97
Cropping system (S)						
Sorghum+cowpea	2489	2517	1096	6730	7170	2895
Sorghum+pearlmillet	2251	2381	1047	5520	6625	2840
Sole sorghum	2745	2797	1469	7585	7679	4023
SEd	52.3	54.90	61.5	143.2	154.7	71.1
CD (P = 0.05)	108.5	113.8	127.5	297.0	320.8	147.4
Fertilizer level (F) (kg ha^{-1})						
N0 P0	1883	1977	863	5004	5444	2388
N40 P20	2456	2543	1209	6046	6318	2971
N60 P30	2769	2773	1308	7204	7682	3559
N80 P40	2872	2966	1357	8192	9188	4092
SEd	60.4	63.4	71.0	165.4	178.6	82.1
CD (P =0.0:5)	125.3	131.4	147.2	343.0	370.5	170.2
SxF						
SEd	104.6	109.8	123.0	286.5	309.4	142.2
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

Table 2. Yield of cowpea intercropped with sorghum

Treatment	Grain yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
(kg ha^{-1})	1994-'95	1995-'96	1996-'97	1994-'95	1995-'96	1996-'97
N0 P0	288	299	78	576	592	308
N40 P20	298	324	89	634	658	365
N60 P30	310	346	95	667	697	416
N80 P40	316	357	98	750	776	452
SEd	16.78	18.22	5.1	36.8	38.2	21.6
CD (P =0.05)	NS	NS	12.5	90.0	93.5	53.0

Table 3. Yield of pearlmillet intercropped with sorghum

Treatment	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
(kg ha^{-1})	1994-'95	1995-'96	1996-'97	1994-'95	1995-'96	1996-'97
N0 P0	138	126	188	2006	2150	676
N40 P20	143	138	225	2113	2184	859
N60 P30	146	140	258	2304	2378	912
N80 P40	151	147	261	2429	2496	1016
SEd	12.1	12.1	12.6	120.1	121.5	38.5
CD (P =0.05)	NS	NS	30.8	294.2	297.7	94.3

ield in sorghum + pearlmillet system (1047 g ha^{-1}).

With regard to the fertilizer levels, during irst year, application of fertilizers at N80 : P40 g ha^{-1} and N60 : P30 kg ha^{-1} significantly ncreased the grain yield of sorghum (2872 and 769 kg ha^{-1}). Similar trend was noticed during hird year. During second year there was a linear esponse to applied fertilizers. The plots which id not receive any fertilizer registered signifiantly lower grain yield in all the three years. n general the grain yield of sorghum was comparatively lower during third year in all the cropping systems irrespective of fertilizer levels. The main reason for this was the poor rainfall during this period.

Straw yield of sorghum

Sole sorghum recorded the highest straw yield of 7585, 7679 and 4023 kg ha^{-1} during the first, second and third years, respectively (Table 1). The straw yield of sorghum significantly reduced when grown in association with pearlmillet during first and second years and it was comparable with the straw yield of sorghum grown with cowpea during third year. Different fertilizer levels influenced the straw yield. Increase in straw yield was observed at increasing levels of fertilizers. Application of N80 : P40 kg ha^{-1} produced higher straw yield of 8192, 9188 and 4092 kg ha^{-1} during first, second and third years respectively. A linear response to applied fertilizer was noticed.

Grain yield of cowpea (Table 2)

Application of fertilizers to sorghum did not exert any significant influence on the grain yield of cowpea during first two years of experimentation. However, during third year different levels of fertilizer application to sorghum significantly influenced the grain yield of intercropped cowpea when compared to no application of fertilizer. Higher doses of fertilizer (N80 : P40 kg ha^{-1}) produced cowpea yield of 316, 357 and 98 kg ha^{-1} during first second and third years, respectively.

Haulm yield of cowpea

The haulm yield of cowpea (Table 2) was influenced by the application of different levels of fertilizer to sorghum. Application of N80: P40 and N 60:P 30 kg ha^{-1} to sorghum were comparable in registering the haulm yield of cowpea in all the three years of study. Application of N60:P30 and N40:P20 kg ha^{-1} were comparable in producing cowpea haulms during last two years of experimentation. Application of higher levels of fertilizers (N80: P40 kg ha^{-1}) to sorghum produced cowpea haulm yield of 750, 776 and 452 kg ha^{-1}, respectively during first, second and third years respectively.

Grain yield of pearlmillet (Table 3)

Application of fertilizers at different levels to maincrop of sorghum increased the grain yield of intercropped pearlmillet. However, it did not reach the level of significance in the first two years of experimentation. During third year, application of higher levels of fertilizers (N80:P40 and N60:P30 kg ha^{-1}) significantly increased the grain yield of intercropped pearlmillet.

Straw yield of pearlmillet

Application of fertilizers to maincrop of sorghum increased the straw yield of intercropped pearlmillet (Table 3). Application of N80:P40 and N60:P30 kg ha^{-1} produced higher straw yield of pearlmillet, however, application of N60:P30 was comparable with N40: P20 kg ha^{-1} and in turn it was comparable with no fertilizer application. During third year, application of fertilizers at N80:P40 kg ha^{-1} to main crop sorghum significantly increased the straw yield of pearlmillet. Application of higher levels of fertilizer to sorghum produced straw yield of 2429, 2496 and 1016 kg ha^{-1} by intercropped pearlmillet during first, second and third years, respectively.

When two crops were grown in mixed stand, both of them generally gave lesser yield than that of their respective yield in monocultures. The results from this study confirm the earlier findings that a near full yield of sorghum could be obtained in intercropping situation with legumes such as cowpea (Kunasekaran *et al.* 1980; Natarajan and Willey, 1980; Gangwar, 1986). Harwood and Price (1975) reported that in their experiments crop failure often occurred after considerable intercrop competition had already taken place, so they considered that sole cropping might be more stable. In the present study also sole sorghum was found to be more stable than intercrop.

The variation in the yield of sorghum in sole cropping and intercropping was mainly due to the quantity and distribution of rainfall in the three years rather than the effect of intercrop competition. Moreover, in replacement series of experimental design, reduction in maincrop yield was due to the lower plant density in intercropping. In this experiment, sorghum population was only 98,765 plants per hectare in intercropping as compared to 1,48,148 plants per hectare in solecropping. On the basis of plant population, the expected yield of main crop was only 66 per cent of sole crop yield in intercropping experiment.

During first two years, the rainfall received during crop growth period was 503.7 mm in 29 rainy days and 565.9 mm in 29 rainy days, respectively. Hence the minimum variation in grain yield of sorghum under sole cropping and intercropping. The third year was characterised by low rainfall as well as early cessation of rainfall. The occurrence of drought at the end crop season was found to reduce the yield of sorghum in both solecropping and intercropping. In intercropping studies at ICRISAT, Rao and Willey (1983) reported similar effects of the late dry spells on the grain yield of long duration sorghum.

Inspite of differences in rainfall quantity and distribution between years, sorghum produced higher straw in first two years due to its tall nature and higher dry matter accumulation. The straw yield reduction during third year could be attributed to lack of sufficient rains during the critical periods of growth from the beginning. Similar findings were reported by Mulik *et al.* (1996). Another reason attributed for higher yield of sorghum was the increased availability of nutrients. They might have increased the metabolic activities of sorghum.

Thus it was concluded that sorghum yield was higher when grown as sole crop. The response of component crops were linear to applied fertilizers to maincrop. The yield of component crops were higher in normal rainfall years and were reduced in the low rainfall year. Pearlmillet was a better intercrop with sorghum than cowpea.

References

Gangwar, B. (1986). Studies on sorghum-legume intercropping. *Indian J. Agric. Sci.*, **31:** 407-408.

Hall, R.L. (1974). Analysis of the nature of interference between plants of different species. II Nutrient relations in a Nandi stair and greenleaf desmodium association with particular reference to potassium *Aust. J Agric. Res.* **25:** 749-756.

Hafl, R.L. (1978). The analysis and significance of competitive and non competitive interference between species. In: J.R. Wilson (Editor), Plant relations in pastures. CSIRO, Melbourne, vic. pp. 163-174.

Harwood, R.R. and Price E.C. (1975). Multiple cropping in Tropical Asia In: Multiple cropping symposium (Proc.) Ann. Soc. Agron., Ann. Meeting. Knoville, Tennessee, 24-29th August.

Kunasekaran, V., Jayaraman, R, Chowdappan S.R and Sreeramulu, U.S. (1980).Intercropping in rainfed sorghum. *Madras Agric. J.* **67:** 816-818.

Mulik, S.P, Ghadge, H.L., Jadhav A.S. and Patil J.D. (1996). Response of winter sorghum *(Sorghum bicolor)* varieties to sowing time and nitrogen. *Indian J Agron.* **41:** 252-255.

Natarajan, M. and Willey, R.W. (1980). Sorghum-pigeonpea intercropping and the effects of plant population density. 2. Resource use. *J. Agric. Sci., Camb.*, **95:** 59-65.

Rao, M.R. and Willey, R.W. (1983). Effects of genotype in cereal / piegeonpea intercropping on the alfisols of the semi-arid tropics of India. *Expl. Agric.*, **19:** 67-78.

(Received: June 2001; Revised : January 2002).