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EFFECT OF NUTRIENT OMISSION STUDIES ON GROWTH AND YIELD OF *RABI* SORGHUM CROP UNDER *VERTISOLS*

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ABSTRACT

A field experiment was conducted at Reginal Agricultural Research station, Nandyal, Acharaya N.G. Ranga Agricultural University during *rabi* 2020-21 and 2021-22 on nutrient omission studies on growth and yield of *Rabi* Sorghum crop. The present study revealed that the growth parameters viz., plant height, panicle weight, panicle length, dry matter production, 1000 seed test weight, grain yield and stover yield at harvest were significantly higher with application of 100 % NPK or no omission (T_1) followed by application of 100 % NK (T_3) and 100 % NP (T_4) whereas, lower growth parameters and yield were noticed with omission of all major nutrients to the crop *i.e.*, control and the economic evaluation of nutrient omission studies in grain sorghum crop revealed that maximum net returns (Rs. 74,247 ha^{-1}) and highest B:C ratio (2.42) were obtained with application of 100 % NPK or no omission treatment. Omission of either nitrogen, phosphorus, potassium alone or nitrogen and phosphorus adversely affected growth parameters, yield and yield components of *rabi* sorghum.

KEY WORDS : Nutrient omission studies, Rabi-Sorghum.

INTRODUCTION

Sorghum (*Sorghum bicolor L. Moench*) is a staple food crop in semi-arid areas considered as the king of millets and fourth important crop in the country after rice, wheat and maize. It is the most effective C4 plant as far as photosynthesis pathway is concerned. In India, sorghum is grown in 4.82 m ha with a productivity of 989 kg ha^{-1} (Anon., 2020). Increasing crop production is imperative to meet the growing demand of the population in terms of food, fodder, fiber, fuel, timber and industrial raw material. A continuous increase in yield performance has been achieved through progress in breeding and improvements in crop management systems. Fertilizer use has been the key element of this remarkable situation including the high yielding genotypes to realize the potential yield. Presently there is either a plateau or decline in the productivity of many crops across the country, despite earlier steady increase in productivity. The stagnation in crop productivity has been found due to deficiency of some micro and secondary nutrients (Sakal, 2001). Fertilizer is one of the most important sources to meet the target yield. Indiscriminate use of fertilizers may cause adverse effect on soils and crops both nutrient toxicity and deficiency either by over use or inadequate use. Thus the current investigation was designed to determine the effect of nutrient omission under rainfed and irrigated condition on growth and yield parameters of *rabi* sorghum. The soil test based blanket fertilizer recommendations of researchers though have scientific merit have not reached to all to the farmers and many of them are not convinced with the approach. At this juncture, site specific nutrient management (SSNM) concept developed through omission plot technique (OPT) comes handy as it not only avoids the need for chemical analysis of soil in the laboratory but also uses grain yield as

measurement indices (Dobermann and Fairhurst, 2000) that farmers can see physically and get convinced. Omission plot is one where adequate amounts of all nutrients are applied except for thenutrient of interest (the omitted nutrient).

The omission plot technique is used to estimate fertilizer requirements. In an omission plot, adequate amounts of all nutrients are applied except for the nutrient of interest (the omitted nutrient). The yield in such an omission plot is related to the indigenous soil supplying capacity of the omitted nutrient. The yield gap between a target yield and the yield in the omission plot is then used to calculate fertilizer requirements. The yield from nutrient omission and non-omission plots provide information about the indigenous soil supplying capacityand crop response, respectively from which farmspecific nutrient recommendations can be arrived atfor a targeted yield. Balance fertilized (more often NPK fertilized) plot yield with recommended crop management practices is taken as targeted yield. This approach is ideal to islands where farms are scattered and to get soil testing data is very difficult. Keeping the above facts in view, a field experiment was conducted to study the effects of nitrogen (N), phosphorus (P) and potassium (K) *i.e.* primary nutrients on growth, productivity and profitability of rice using nutrient omission plot technique (NOPT) on research farm. The indigenous nutrient supplies of soil and nutrient use efficiency indices were also worked out besides coming out the omittable nutrient in rice cropping.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2020-21 and 2021-22 at Regional Agricultural Research Station, Nandyala under Irrigated dry (ID) conditions. The soil of experimental site was medium deep black, low in organic carbon (0.25 %) & Nitrogen (140 kg ha^{-1}) high in available P_2O_5 (58.65 kg ha^{-1}) and available K_2O (435 kg ha^{-1}). The experiment was laid out in randomised block design with treatments comprised of eight treatments, wherein, T_1-No omission (NPK), T_2-N omission (PK), T_3-P omission (NK), T_4-K omission (NP), T_5-NP omission (K), T_6-NK omission (P), T_7-PK omission (N) and T_8-NPK omission (control) with three replications. The sorghum variety NTJ-5 was used with a seed rate of 5 kg ha^{-1} at a spacing of 45 cm x 15 cm and with a recommended fertilizer dose of 80-60-40 NPK kg ha^{-1}. The data related to plant height and yield attributes was recorded on ten randomly selected plants in each plot. Net grain and stover yield were recorded for net plot and computed as kg ha^{-1}. Soil and plant samples were collected in each treatment and analyzed by following standard procedures. The data collected were subjected to statistical analysis as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results pertaining to growth and yield attributes of *rabi* sorghum crop of two years 2020-21 and 2021-22 were presented in Table 1. The present study revealed that the growth parameters viz., plant height panicle weight, panicle length, dry matter production, 1000 seed test weight, grain yield and stover yield at harvest were significantly higher with application of 100 % NPK or no omission (T_1) followed by application of 100 % NK (T_3), 100 % NP (T_4) whereas, lower growth parameters and yield were noticed with omission of all major nutrients to the crop *i.e.,* control (Table 1). Application of 100 % NPK (No omission or T_1) recorded significantly higher plant height (146 cm), panicle length (20.5 cm), panicle weight (101 g $plant^{-1}$), 1000 – seed weight (38.13 g) dry matter at harvest (8453 kg ha^{-1}, grain yield (4303 kg ha^{-1}) and stover yield (8068 kg ha^{-1}) followed by application of 100% NK (P omission or T_3) in plant height (141 cm), panicle length (19.6 cm), panicle weight (97.1 g $plant^{-1}$), 1000 – seed weight (37.47 g) dry matter at harvest (8297 kg ha^{-1}), grain yield (4018 kg ha^{-1}) and stover yield (7772 kg ha^{-1}) over control but at par with application of NP (K omission or T_4). The higher yield and yield parameters might be due to better photosynthates and translocation of nutrients.

Higher yield attributes of rice due to application of all nutrients is attributed to improvement in growth which in turn translocation of photosynthates and nutrients in the reproductive parts resulted more yield attributes (Singh, 2018 and Singh *et al.,* 2018). The increase in plant height, panicle length, panicle weight, 1000 – seed weight and total dry matter accumulation might be due to availability of adequate moisture at all critical stages of the crop plant which in turn led to the increased absorption and utilization of applied nutrients. Increase in leaf area was due to the increase in plant height under the application of recommended dose of fertilizer, which enhanced the interception, absorption and utilization of radiant energy which

Table 1. Growth and yield attributes affected by nutrient omission in grain sorghum

Treat-ment		Plant height at harvest (cm)	Days to 50% flowering (days)	Days to physiological maturity (days)	Dry matter at harvest (kg/ha)	Panicle wt (g)	Panicle Length (cm)	1000 seed weight (g)	Grain yield (kg/ha)			Stover yield (kg/ha)		
									2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T1:	No Omission (NPK)	146.0	65.3	114.3	8453	101.0	20.5	38.13	3853	4752	4303	8487	7648	8068
T2:	N omission (PK)	127.7	71.3	113.3	8016	79.4	15.3	35.33	3235	3680	3458	7956	6115	7035
T3:	P omission (NK)	141.0	68.3	114.0	8297	97.1	19.6	37.47	3674	4362	4018	8380	7164	7772
T4:	K omission (NP)	138.7	68.3	115.0	8164	95.3	19.1	36.77	3579	4223	3901	8320	7018	7669
T5:	NP Omission (K)	124.0	72.7	115.7	7923	76.6	14.8	35.30	3157	3371	3264	7717	5744	6731
T6	NK Omission (P)	119.7	73.3	116.7	7540	73.5	14.4	34.30	3066	3081	3074	7541	5482	6511
T7	PK omission (N)	136.0	71.0	116.3	8116	93.4	17.2	36.20	3367	3858	3612	8093	6753	7423
T8	NPK omission (control)	112.7	**75.7**	117.7	7069	67.7	13.5	32.87	2208	2286	2247	7165	4551	5858
	SEm±	1.1	0.4	1.6	40	1.3	0.4	0.4	67	120	55	52	137	69
	CD(P=0.05)	3.3	1.3	NS	123	3.9	1.1	1.3	207	366	153	160	421	193
	CV (%)	9.7	2.2	2.5	9	2.6	3.7	2.3	7	6.58	6.2	11	12.1	10.5

in turn increased leaf area index, photosynthesis and finally accumulation of dry matter per plant. The results obtained in this study are in line with Sujathamma *et al*. (2014). Nour and Lazin (2000) reported that nitrogen and phosphorus combination affected grain yield significantly. Malik *et al*. (1976) also reported that the interaction effect of nitrogen and phosphorus increased grain yield significantly. Amanullah and Khalil (2010) observed that increased level of phosphorus produced higher grain and stover yield that might be due to increase in yield and yield components. Ibrikci *et al*. (2005) reported that the deficiency of phosphorus limited the growth and yield of maize. Singaram and Kothandaraman (1994) also recorded increment in phosphorus increases the yield. Nandal and Agrawal (1991) reported a linear response of maize to nitrogen application up to 200 kg ha^{-1} than that of (0 to 150 kg ha^{-1}). The grain and straw yield reductions were observed more with N and P omission followed by K omission. This indicates that N was the most yield limiting nutrients in soils followed by P. Under tropical climatic conditions, oxidation loss of organic matter results in low organic carbon and ultimately in available nitrogen causing much reduction in yields (Singh *et al.,* 2000).

Singh *et al.* (1993) also reported response of increase in maize yield and attributes up to 150 kg ha^{-1} of nitrogen application. Tyagi *et al.* (1998) reported that a grain yield of maize increased from 61 to 137 percent with the increment of nitrogen from 75 to 250 kg ha^{-1} as compared to nitrogen omission soil. Padmaja *et al.* (1999) also reported similar type of findings that the grain and stover yields were increased significantly with the increment in nitrogen level from 0 to 150 kg ha^{-1}. Similar trend of findings were also reported by Singh *et al.* (2000), Suryavanshi *et al.* (2008) and Mahmood *et al.* (2001). Omission of NPK or control reduced plant height, total dry matter accumulation, grain yield and stover yield to an extent of 23.0, 16.37, 47.78 and 27.39 per cent respectively over no omission or application of 100%NPK (T_1). The results are similar to those of Joshi *et al.* (2016), who reported that growth and yield attributes were significantly influenced by nutrient omission treatments and their values were higher when nutrient were applied according to STCR approach. The increased grain yield and yield parameters were due to favorable moisture condition which helped for better translocation of photosynthates. The results are in line with the study shows that maize

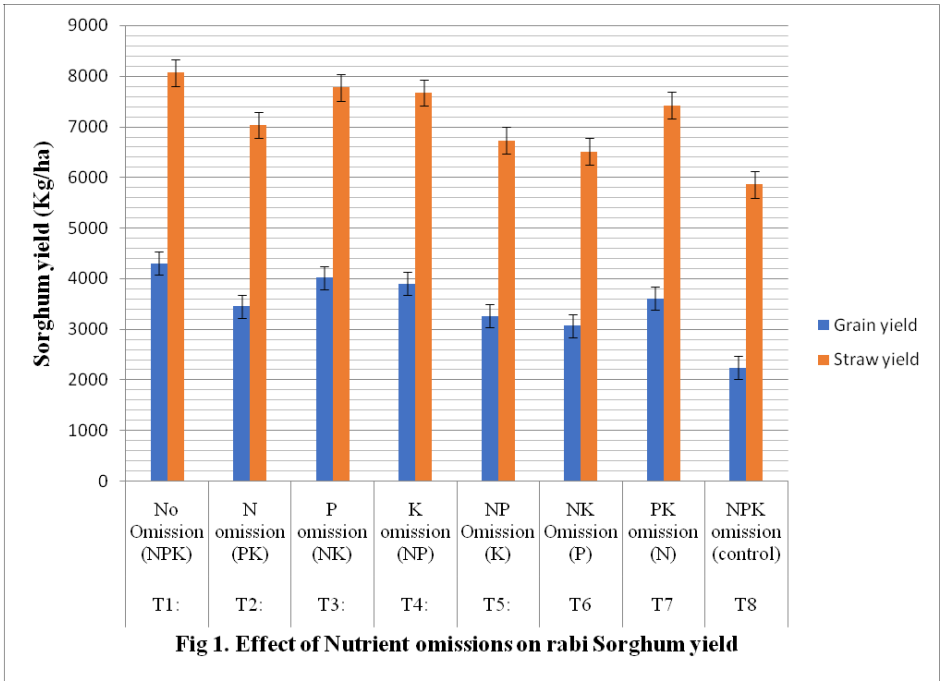

Fig 1. Effect of Nutrient omissions on rabi Sorghum yield

grain yield was the highest for the NPK treatment followed by NPK+ treatment but lowest for the unfertilized control and N omitted plots (Atnafu *et al*., 2021).

Economics

The economic evaluation of nutrient omission studies in grain sorghum crop revealed that maximum net returns (Rs. 74,247 ha^{-1}) and highest B:C ratio (2.42) were obtained with application of 100 % NPK or no omission treatment (Table 2) followed by maximum net returns (Rs. 67,663 ha^{-1}) and highest B:C ratio (2.39) were obtained with application of 100 % NK or P omission treatment in grain sorghum. But the application of no NPK or control (T_8) recorded lowest B: C ratio (1.37) and lower net income of Rs 56,965 ha^{-1}. Similar economic benefits have been reported by Thavaprakash and Malligawad (2002) in sunflower and Anand (2010) in chickpea and maize.

CONCLUSION

The present study revealed that the growth parameters viz., plant height, panicle weight, panicle length, dry matter production, 1000 seed test weight, grain yield and stover yield at harvest were significantly higher with application of 100 % NPK or no omission (T_1) followed by application of 100 % NK (T_3), 100 % NP (T_4) whereas, lower growth parameters and yield were noticed with omission of all major nutrients to the crop *i.e.*, control and the economic evaluation of nutrient omission studies in grain sorghum crop revealed that maximum net

Table 2. Economics affected by nutrient omission in grain sorghum

Treatment	Cost of cultivation (Rs /ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit :cost ratio	(B:C ratio)
T1:	No Omission (NPK)	52201	126448	74247	2.42
T2:	N omission (PK)	50963	98115	47152	1.92
T3:	P omission (NK)	48551	116214	67663	2.39
T4:	K omission (NP)	50888	112593	61705	2.21
T5:	NP Omission (K)	46313	90019	43706	1.94
T6	NK Omission (P)	49650	82507	32857	1.66
T7	PK omission (N)	46238	103203	56965	2.23
T8	NPK omission (control)	45000	61701	16701	1.37

returns (Rs. 74,247 ha^{-1}) and highest B:C ratio (2.42) were obtained with application of 100 % NPK or no omission treatment. Omission of either nitrogen or phosphorus alone or both nitrogen and phosphorus adversely affected growth parameters, yield and yield components of rabi sorghum.

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