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EFFECT OF INTEGRATED NITROGEN MANAGEMENT ON GROWTH, YIELD AND ECONOMICS OF *KHARIF* SORGHUM (*Sorghum bicolor* L.)

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ABSTRACT

An experiment was conducted at College of Agriculture, Nagpur to study the"Effect of integrated nitrogen management on *kharif* sorghum (*Sorghum bicolor* L.)" using different organic and inorganic fertilizers during *kharif* season of 2016-17 in randomized block design with three replications. The treatments includedT_1-100% N through urea, T_2-100% N through neem coated urea, T_3-75% N through urea + 25% N through FYM, T_4-75% N through neem coated urea + 25% N through FYM, T_5-100% N through urea + 10 kg humic acid ha^{-1}(granular), T_6-100% N through neem coated urea + 10 kg humic acid ha^{-1} (granular), T_7-.75% N through urea + 25% N through FYM + 10 kg humic acid ha^{-1} (granular) and T_8-75% N through neem coated urea + 25% N through FYM + 10 kg humic acid ha^{-1}(granular). The results of the study indicated that application of 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular) recorded higher growth and yield characters viz., plant height, number of functional leaves plant^{-1}, leaf area plant^{-1}, dry matter plant^{-1}, length of earhead, test weight and grain and straw yield (q ha^{-1}) .Perusal of the data indicated that GMR,NMR and B:C ratio significantly higher in 100% N through neem coated urea + 10 kg humic acid ha^{-1}.

(Key words: Sorghum, nitrogen, growth, yield and economics)

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is one of the world's leading cereal providing food, fuel, and biofuels feedstock across range of environments and production systems. It is cultivated globally, being one of the most important cereal crop worldwide. Its remarkable ability to produces a crop under adverse conditions in particular with much less water than other grain crops make sorghum important source of global agro ecosystem. Increased demand for fresh water and expanding population suggest that dryland crops such as sorghum will be increasing importance.

It is fifth most important cereal crop in world production after wheat, maize, rice and barley. It ranks fourth in acreage and production among the cereals in India. It is a major dry land food grain crop. It is best adopted in area of low rainfall. In Maharashtra it is truly the poor man's bread. The large scale grain production through application of chemical fertilizers is base of green revolution. However, unjudicious use of fertilizers adversely affects the productivity of crop and properties of soil. The chemical fertilizers no doubt are important sources which can meet the nutrient requirement but their imbalanced and continuous use lead to deterioration of physico-chemical properties of soil.

The area under sorghum in India is about 58.2 lakh hectares with an annual production of 53.9 lakh tonnes. In case of Maharashtra, area and production of sorghum is 2.3 lakh hectares and 2.9 lakh tonnes respectively. (Anonymous, 2015).

Humic acid has been reported to influence the plant growth both directly and indirectly. The indirect effect of humic compounds has been attributed to the important of physical, chemical and biological condition of a soil. Its direct effect on plant growth has been attributed to the increase chlorophyll content, the acceleration of the respiration process, hormonal growth responses increasing penetration in plant membrane or combination of these processes.

However, scarcity of FYM and other organic manure necessitates the use of other alternative sources in conjunction with chemical fertilizers for supplementing plant nutrients. The present investigation was therefore, conducted to study the effect of humic acid as a supplementary source of nutrient.

Use of organic manure with optimum rate of fertilizer under intensive farming system increases the turn of nutrient in soil plant system. Long term experiment have indicated the favorable effect of FYM, humic acid and neem coated urea on physical properties of the soil and also as a source of plant nutrient which are released on its mineralization and become available to plant, the application of organic manure along with recommended dose of fertilizer

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not only produce higher yield but also provide greater yield stability.

Nitrogen, being deficient in our soils, has to be applied in relatively large amounts for obtaining optimum crop yield. The applied nitrogen is subjected to various transformations and losses in the soil such as denitrification, volatilization and leaching. To overcome the deficiency and for efficient utilization of applied fertilizer nitrogen, these losses are to be minimized by applying appropriate source and rate of nitrogen.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy farm, College of Agriculture, Nagpur during *kharif* season of 2016-17.The experiment was laid out in randomized block design with three replications.The treatments consisted of T_1-100% N through urea, T_2-100% N through neem coated urea, T_3-75% N through urea + 25% N through FYM, T_4-75% N through neem coated urea + 25% N through FYM, T_5-100% N through urea + 10 kg humic acid ha^{-1}(granular), T_6-100% N through neem coated urea + 10 kg humic acid ha^{-1} (granular), T_7-.75% N through urea + 25% N through FYM + 10 kg humic acid ha^{-1} (granular) and T_8- 75% N through neem coated urea + 25% N through FYM + 10 kg humic acid ha^{-1}(granular). The soil of experimental plot was vertisol, fairly uniform and leveled. low in available nitrogen (230.32 kg ha^{-1}), medium in phosphorus (375.42 kg ha^{-1}) and organic carbon (0.52 %) and very high in available potash (375.42kg ha^{-1}) and slightly alkaline in reaction (pH 7.60).

The crop variety CSH-9 was used with gross plot size of 5.4 m ×4.8 m and net plot size of 4.8 m × 3.4 m. As per the treatment, the quantity of FYM, fertilizer required plot^{-1} was calculated. FYM was applied before sowing. Nitrogen was applied as per treatments through urea in two splits i.e. ½ at sowing and remaining at 30 days, 10 DAS application of humic acid. Full dose of phosphorus and potash was applied at the time of sowing to all the plots as per treatment through single super phosphate and muriate of potash, respectively.

In order to represent the plot, five plants of sorghum from each net plot were selected randomly, labeled properly. The growth attributing characters *viz.,* plant height, leaf area plant^{-1} and dry matter accumulation plant^{-1} were recorded at 30,60,90 DAS and at harvest and yield attributing characters and yield *viz.,*length of ear head,grain yield plant^{-1}, test weight, grain and fodder yield (q ha^{-1}) were also recorded at harvest.The gross monetary and net monrtary returns along with B:C ratio were calculated.

RESULTS AND DISCUSSION

Effect of Integrated nitrogen management on crop growth

Plant height

The data pertaining to mean plant height as influenced by different treatments are presented in table 1.Data from table 1 indicated that integrated nitrogen management treatments significantly influenced the plant height at all growth stages.

At 60 and 90 DAS, treatment 100% N through neem coated urea +10 kg humic acid ha^{-1}(granular)(T_6) recorded significantly higher plant height over all other treatments. However, it was found at par with 100% N through urea + 10 kg humic acid ha^{-1}(granular)(T_5) and 75% N through neem coated urea + 25% N through FYM + 10 kg humic acid ha^{-1} (granular) (T_8).

At harvest application of 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular)(T_6) was also recorded significantly highest plant height over the application of 100% N through urea (T_1), 100% N through neem coated urea (T_2), 75% N through urea + 25% N through FYM (T_3), 75% N through neem coated urea + 25% N through FYM (T_4) and 75% N through urea + 25% N through FYM + 10 kg humic acid ha^{-1} (granular) (T_7), and it was found at par with 100% N through urea + 10 kg humic acid ha^{-1}(granular) (T_5) and75% N through neem coated urea + 25% N through FYM +10 kg humic acid ha^{-1} (granular)(T_8). This might be due to use of readily and slow availability of nitrogen through the organic fertilizer in adequate quantity at proper stage might have resulted in optimum cell division and cell enlargement, which ultimately enhanced the plant height.

Samuel *et al*. (2012) reported that application of nitrogen with increasing level up to 120 kg ha^{-1} increased plant height over control in sorghum.

Dry matter accumulation plant^{-1}

The data pertaining to mean dry matter accumulation plant^{-1}as influenced by different treatments are presented in table 1.Data from table 1 indicated that integrated nitrogen management treatments significantly influenced the dry matter accumulation plant^{-1}at all growth stages.

Integrated nitrogen management treatments influenced the dry matter accumulation significantly at 60, 90 DAS and harvest except 30 DAS.

At 60, 90 and at harvest 100% N through neem coated urea + 10 kg humic acid ha^{-1}(T_6) produced significantly more dry matter accumulation plant^{-1} over all other treatments and it was found at par with 100% N through urea+ 10 kg humic acid ha^{-1}(granular) (T_5) and 75% N through neem coated urea + 25% N through urea + 10 kg humic acid ha^{-1}(granular) (T_8).

Maximum dry matter accumulation plant^{-1}(134.79 g) was recorded in 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular)(T_6), while minimum (113.65 g) was recorded in 75% N through urea + 25% N through FYM (T_3).Dry matter accumulation is a result of photosynthesis and the cumulative effect of all growth attributes. It might be due to more number of leaves resulted in more synthesis of photosynthetic in growing region, meristematic tissue and ultimately enhances cell division.

Afzal *et al*. (2012) reported that application of nitrogen with increasing level up to 100 kg ha^{-1}increased dry matter accumulation $plant^{-1}$ over control in sorghum.

Leaf area $plant^{-1}$

The data pertaining to mean leaf area $plant^{-1}$as influenced by different treatments are presented in table 1.Data from table 1 indicated that integrated nitrogen management treatments significantly influenced the dry matter accumulation $plant^{-1}$ at all growth stages.

At 60,90 DAS and at harvest treatment of 100% N through neem coated urea + 10 kg humic acid ha^{-1}(T_6) recorded significantly higher leaf area over all other treatments. However, it was found at par with 100% N through urea + 10 kg humic acid ha^{-1}(granular) (T_5) and 75% N through neem coated urea + 25 % N through FYM + 10 kg humic acid ha^{-1} (granular) (T_8).

Maximum leaf area $plant^{-1}$ (36.13 dm^2) was recorded in treatment 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular) (T_6), while minimum leafarea $plant^{-1}$ (28.10dm^2) was noted in treatment 75% N through urea + 25 % N through FYM (T_3) at 90 DAS.

Abdelmuniem and Madhvi (2015) reported that application of nitrogen with increasing level up to 100 % RDN, increased leaf area $plant^{-1}$ over control in sorghum.

Effect on yield attributes

Length of earhead

The data presented in table 2 revealed that earhead length (cm) in sorghum exhibited significant differences among different treatments of integrated nitrogen management. The earhead length was significantly superior in treatment 100% N through neem coated urea+10 kg humic acid ha^{-1}(granular) (T_6) over all other treatments. However, it was found at par with treatment 100% N through urea + 10 kg humic acid ha^{-1}(granular)(T_5) and 75% N through neem coated urea + 25% N through FYM +10 kg humic acid ha^{-1} (granular)(T_8). This might be due to more availability of nutrients through fertilizers increased earhead length.

Abdelmuniem and Madhvi (2015) reported that application of nitrogen with increasing level up to 100 % RDN, increased length of earhead over control in sorghum.

Test weight

The data presented in table 2 revealed that test weight of sorghum exhibited non-significant differences due to different integrated nitrogen management treatments applied to sorghum. Test weight was numerically higher in treatment 100% N through neem coated urea + 10 kg humic acid ha^{-1} (granular)(T_6).

Maximum test weight (29.53 g) recorded in treatment 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular)(T_6),while minimum test weight (27.31 g) recorded in treatment 75 % N through urea + 25% N through FYM (T_3).

Ghosh *et al*. (2003) reported that combination of organic and inorganic fertilizers recorded highest test weight of sorghum as compared to sole inorganic fertilizer (100%, 75% NPK), control (no fertilizer).

Grain yield ha^{-1}

The data presented in table 2 revealed that grain yield q ha^{-1} of sorghum was influenced significantly due to different integrated nitrogen management treatments 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular)(T_6) recorded higher grain yield over all other treatments except 100% N through neem coated urea+10 kg humic acid ha^{-1}(granular) (T_6) and 100% N through urea + 10 kg humic acid ha^{-1}(granular)(T_5).

Maximum grain yield ha^{-1}(48.68 q ha^{-1}) recorded in treatment 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular) (T_8), while minimum grain yield ha^{-1}(39.13 q ha^{-1}) recorded in treatment 75% N through urea + 25% N through FYM (T_3).The increase in grain yield ha^{-1} might be due to maximum utilization of nutrients.

Jadhav *et al.* (2012) reported that integrated nitrogen application with 150 per cent RDN in the form of 75 per cent RDN through chemical fertilizer + 25 per cent RDN ha^{-1} through FYM to maize gave maximum grain yield (51.46 q ha^{-1}) over control.

Straw yield ha^{-1}

The data presented in table 2 revealed that straw yield (q ha^{-1}) was significantly differ due to different integrated nitrogen management treatments. The straw yield was significantly higher with 100% N through neem coated urea + 10 kg humic acid ha^{-1}(granular) (T_6) over all other treatments and it was found at par with 100% N through urea + 10 kg humic acid ha^{-1}(granular) (T_5) and75% N through urea + 25% N through FYM +10 kg humic acid ha^{-1} (granular) (T_8).

Maximum straw yield ha^{-1} (76.85 q) was recorded in treatment 100% N through neem coated urea + 10 kg humic acid ha^{-1}(T_8), while minimum straw yield ha^{-1}(54.29 q) was recorded in treatment 75% N through urea + 25 % N through FYM (T_3). The results indicated that the increase in straw yield was related to the availability of nutrient mainly nitrogen by neem coated urea and humic acid helped in reducing the leaching and volatilization losses there by accelerated the availability. This might be the reason for increase in straw yield ha^{-1} in the present investigation.

Deshmukh *et al.* (2013) reported that application of 100% of the recommended dose of fertilizers or RFR (80:40:40 NPK kg ha^{-1}) registered the highest straw yield over control in sorghum.

Economic studies

Data on gross monetary return, net monetary return and B: C ratio as affected by various nitrogen treatments are presented in table 2.

Perusal of the data indicated that GMR(75245ha^{-1}), NMR(48385 ha^{-1}) and B: Cratio (2.80) was significantly higher in 100% N through neem coated urea + 10 kg humic acid ha^{-1} (T_6). Hence, this treatment can be considered as beneficial treatment.

Anil kumar *et al.* (2002) noticed that application of 150% RDF ha^{-1} to maize resulted in the maximum GMR, NMR and B: C ratio.

Table 1.Effect of integrated nitrogen management on growth of sorghum

Treatments	Plant height (cm)				Leaf area plant^{-1} (dm^2)				Dry matter accumulation plant (g)			
	30 DAS	60 DAS	90 DAS	at harvest	30 DAS	60 DAS	90 DAS	at harvest	30 DAS	60 DAS	90 DAS	at harvest
T_1-100% N through urea	28.62	137.94	199.89	210.16	9.92	26.57	29.68	28.54	14.09	61.45	108.12	119.79
T_2-100% N through neem coated urea	29.10	138.55	202.76	212.00	9.78	26.57	30.17	29.30	14.32	62.03	109.53	121.50
T_3-75% N through urea + 25% N through FYM	28.43	133.86	196.38	205.60	9.71	26.17	28.10	27.10	12.42	57.60	104.41	113.65
T_4-75% N through neem coated urea + 25% N through FYM	28.87	136.32	199.74	206.88	9.76	26.41	29.02	27.71	13.45	59.91	105.79	116.45
T_5-100% N through urea+ 10 kg humic acid ha^{-1}(granular)	29.74	148.16	211.41	225.55	9.95	29.80	33.21	31.72	18.11	66.59	115.05	126.25
T_6-100% N through neem coated urea +10 kg humic acid ha^{-1} (granular)	31.70	155.55	217.44	229.18	10.05	30.63	36.13	34.53	21.34	71.64	124.59	134.85
T_7-75% N through urea + 25% N through FYM +10 kg humic acid ha^{-1} (granular)	29.11	139.46	204.28	212.50	9.98	27.18	30.58	29.56	14.59	63.31	112.87	122.48
T_8- 75% N through neem coated urea+25% N through FYM +10 kg humic acid ha^{-1}(granular)	29.13	144.01	207.97	218.96	10.26	28.10	32.73	31.48	16.42	64.51	114.09	123.32
S E (m) ±	1.19	4.34	3.85	5.39	0.50	1.10	1.14	1.06	1.81	2.35	3.90	3.90
C D at 5%	-	12.90	11.00	15.98	-	3.08	3.40	3.18	-	7.00	11.60	11.60

Table 2. Effect of integrated nitrogen management on yield contributing parameters, yield and economics of sorghum

Treatments	Length of earhead (cm)	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	GMR	NMR	B:C ratio
T_1-100% N through urea	21.80	28.04	39.80	56.98	58930	32549	2.23
T_2-100% N through neem coated urea	22.30	28.07	41.64	59.90	62416	36433	2.40
T_3-75% N through urea + 25% N through FYM	21.24	27.31	39.13	54.29	58530	33247	2.31
T_4-75% N through neem coated urea + 25% N through FYM	21.28	27.60	39.28	56.07	59219	33947	2.34
T_5-100% N through urea+ 10 kg humic acid ha^{-1}(granular)	26.90	29.02	46.38	71.71	70638	44846	2.73
T_6-100% N through neem coated urea +10 kg humic acid ha^{-1} (granular)	28.81	29.53	48.68	76.85	75245	48385	2.80
T_7-75% N through urea + 25% N through FYM +10 kg humic acid ha^{-1} (granular).	23.21	28.38	42.10	66.42	67447	42959	2.75
T_8- 75% N through neem coated urea+25% N through FYM +10 kg humic acid ha^{-1}(granular)	25.61	28.66	44.45	69.55	63484	38458	2.53
S E (m)	1.20	0.35	2.08	4.01	2850	2850	-
C D at 5%	3.52	-	6.04	11.98	8600	8600	-

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