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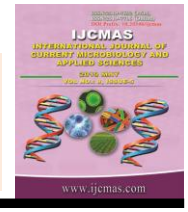

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Effect of Time Nitrogen Fertilizer Application on Growth and Yield of Grain Sorghum

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A B S T R A C T

A study was established for determining the effect of nitrogen (urea) fertilizer method and time of application on the growth and yield of grain sorghum varieties. The experiment was conducted as a Factorial Randomized Block Design replicated thrice comprising five Nitrogen split doses with two varieties during 2014-15 growing season at sorghum research station VNMKV, Parbhani. The main plots were allocated to two genotype G1: CSH 16 & G2: CSV 20 and the subplots were assigned to fertilizer application time viz., N1: 50% N at sowing and 50% at 30 DAS, N2: 50% at sowing + 25% at 30 DAS + 25% at boot-leaf stage (BLS), N3: 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS), N4: 25% at sowing + 50% at 30 DAS +15% at BLS +10 % at grain filling stage (GFS), N5: 25% at sowing + 45% at 30 DAS + 5% at foliar spray at 45 DAS +15 % BLS + 10% at GFS. The results of the experiment revealed that time of N fertilizer application i.e. 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS) gives higher grain and fodder yield over the other treatments. Among genotypes CSH 16 (2982 kg/ha) produced significantly the highest grain yield and fodder yield was significantly higher with CSV 20 (11373 kg /ha) over CSH-16.

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is a crop of world-wide importance and is unique in its ability to produce under a wide array of harsh environmental conditions (House, 1995). Sorghum is an important component in traditional farming systems in the semi-arid tropics of Africa and Asia.

Plant nutrition is an important factor, which directly affects the growth, yield and quality of a crop. Soil contains many mineral nutrients, organic material and water, which are absorbed by plants. If any of these nutrients are deficient or not available in the soil, it affects crop development and a plant shows deficiency symptoms. Therefore, soil nutrient management is necessary for successful crop production. Most of the nutrients are absorbed by plants through their roots from the soil. Nutrient management includes the type of fertilizer to be applied, rate of application and method of application. Nitrogen is the essential element required for plant growth in relatively large amounts.

However, deficiencies of nitrogen are common. Nitrogen deficiency can result in reduced dry matter**,** crude protein and grain yield (Jarvis, 1996; Ashiono *et al.,* 2005). Soil nutrients become depleted due to leaching of nitrogen, soil erosion and removal by crops (Zobeck *et al.,* 2000). In soils with good aeration nitrate (NO_3–) is the dominant form of available nitrogen in higher plants. Its absorption and pattern of distribution in different parts of a plant is very important. Nitrate that is not absorbed by plants may contaminate underground or surface water by nitrate leaching or soil erosion. Increasing Nitrogen Use Efficiency (NUE) in plants is considered as a major way to decrease nitrate accumulation and its leaching in the soil. N source and method of fertilizer application have been identified as factors influencing NUE, as well as the pathway of N loss from the soil-plant system (Raun and Johnson, 1998).

There is difference for NUE, among different sorghum hybrids. Genetic variation was observed for N utilization between early and late-maturity sorghum hybrids. Genotypic variation has been observed for utilization of absorbed N for biomass production and harvest index (Gardner *et al.,* 1994). The best time of nitrogen fertilizer application will significantly improve both quantity and quality of crops as well as NUE (Almodares, 1996).

In a study for determination of suitable time of nitrogen fertilizer application for grain sorghum, it was concluded that, if plants are sown in proper time, three-phase distribution of nitrogen fertilizer has the best effect on total dry weight, protein and height of plants (Kohanmoo and Mazahery, 1995). Application of nitrogen fertilizer at eight-leaf growth stage is feasible and would be beneficial for sorghum (Khosla *et al.,* 2000). Delaying N fertilization 40 days after sowing, rather than applying at sowing, increased dry matter and grain yield of sorghum (Joseph *et al.,* 1997). Grain yield of corn was 10.5 and 11.2 Mg ha^{-1} for nitrogen fertilization at planting and six-leaf stage, respectively (Sainz Rozas *et al.,* 2004).

Materials and Methods

An experiment was conducted during *kharif* 2014-15 at S.R.S. VNMKV Parbhani, in Factorial Randomized Block Design replicated thrice comprising five Nitrogen split doses with two varieties. The main plots were allocated to two genotype G_1: CSH 16 & G_2: CSV 20 and the subplots were assigned to fertilizer application time viz., N_1: 50% N at sowing and 50% at 30 DAS, N_2: 50% at sowing + 25% at 30 DAS + 25% at boot-leaf stage (BLS), N_3: 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS), N_4: 25% at sowing + 50% at 30 DAS +15% at BLS +10 % at grain filling stage (GFS), N_5: 25% at sowing + 45% at 30 DAS + 5% at foliar spray at 45 DAS +15 % BLS + 10% at GFS. The gross and net plot size were 4.5 m X 5.0 m and 3.6 X 4.4 m respectively. The sorghum genotype CSH-16 and CSV-20 were sown on 10^{th} July, 2014 and harvested on 3^{rd} Nov. 2014.

The recommended plant protection schedule was followed. The crops were fertilized as per the treatments. Sorghum was sown with row spacing of 45 cm and seeds 12 cm apart on each row having seed rate 7.5 to 10 kg respectively as per genotype. Important physical and chemical characteristics of soil samples were determined in laboratory including soil texture clay in nature, low in organic carbon (0.58), pH-8.5, low in available nitrogen (166.80 kg/ha) and medium in phosphorus (19.80 kg/ha) and high in potassium (358.50 kg/ha). Treatment details as below

Treatment details

Main plot: G_1: CSH 16 & G_2: CSV 20

Sub-plot: N application methods

N_1: 50% N at sowing and 50% at 30 DAS
N_2: 50% at sowing + 25% at 30 DAS + 25% at boot-leaf stage (BLS)
N_3: 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS)
N_4: 25% at sowing + 50% at 30 DAS +15% at BLS +10 % at grain filling stage (GFS)
N_5: 25% at sowing + 45% at 30 DAS + 5% at foliar spray at 45 DAS +15 % BLS + 10% at GFS

Results and Discussion

Nitrogen Fertilizer time of application had a significant effect on growth and Grain and fodder yield (Table 1).

Grain yield

The splitting of N in three doses i.e. 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS) (3015 kg/ha) produced significantly higher grain yield than rest of treatments, however it was at par with N_5 and N_4. This indicated that three splitting of nitrogen found significantly superior over two splitting.

Table.1 Grain and fodder yield, gross monetary returns, net monetary returns and benefit: cost ratio as influenced by various treatment

Treatments detail	Grain yield (kg/ha)	Fodder yield (kg/ha)	GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
N splitting					
N_1: 50% N at sowing and 50% at 30 DAS	2053	7869	4731	11435	1.29
N_2: 50% at sowing + 25% at 30 DAS + 25% at boot-leaf stage (BLS)	2683	9898	52379	22966	1.53
N_3: 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS)	3015	12068	61008	31808	1.71
N_4: 25% at sowing + 50% at 30 DAS +15% at BLS +10 % at grain filling stage (GFS)	2834	11017	56505	26507	1.59
N_5: 25% at sowing + 45% at 30 DAS + 5% at foliar spray at 45 DAS +15 % BLS + 10% at GFS	2791	10482	54883	24135	1.54
SE+-	79	336	1963	1357	0.03
CD at 5%	236	1008	5889	4071	0.09
Genotypes					
V_1:CSH 16	2982	9160	58947	29516	1.66
V_2:CSV 20	2368	11373	47255	17224	1.41
SE+-	50	213	1241	858	0.02
CD at 5%	149	639	3723	2575	0.06
Interaction					
SE+-	112	476	2775	1919	0.04
CD at 5%	NS	NS	NS	NS	NS
Grand mean	2675	10267	53101	23370	1.53

Table.2 No. of panicles, 50% flowering, physiological maturity, plant height and 100 seed weight as influenced by various treatments

Treatments detail	No. of panicles/m^2	50% flowering (Days)	Physiological maturity (days)	Plant height (cm)	100 seed wt (g)
N splitting					
N_1: 50% N at sowing and 50% at 30 DAS	14	64	116	222	2.85
N_2: 50% at sowing + 25% at 30 DAS + 25% at boot-leaf stage (BLS)	14	64	116	226	3.00
N_3: 25% at sowing + 50% at 30 DAS +25% at Boot leaf stage (BLS)	14	66	118	233	3.27
N_4: 25% at sowing + 50% at 30 DAS +15% at BLS +10 % at grain filling stage (GFS)	14	66	118	232	3.17
N_5: 25% at sowing + 45% at 30 DAS + 5% at foliar spray at 45 DAS +15 % BLS + 10% at GFS	13	65	117	228	3.10
SE+-	0.13	0.40	0.40	1.22	0.25
CD at 5%	NS	1.20	1.20	3.64	NS
Genotypes					
G_1:CSH 16	14	64	116	184	3.32
G_2:CSV 20	14	66	118	272	2.83
SE+-	0.04	0.25	0.25	0.77	0.11
CD at 5%	NS	0.76	0.76	2.30	0.34
Interaction					
SE+-	0.19	0.57	0.57	1.73	0.25
CD at 5%	NS	NS	NS	NS	NS
Grand mean	14	65	117	228	3.08

Fodder yield

The fodder yield was highest under treatment N_3 (12068 kg/ha) than other nitrogen splitting. This might due to availability of nitrogen up to boot leaf stage.

Genotypes

Grain yield

Hybrid CSH 16 (2982 kg/ha) produced significantly the highest grain yield than CSV 20 (2368 kg/ha). This might be due to genetic characteristic of genotypes.

Fodder yield

Fodder yield was significantly higher with CSV 20 (11373 kg/ha) as compared to CSH 16 (9160 kg/ha), because variety produces higher fodder yield than hybrid.

Economics

The application of three split doses of N i.e. 25% at sowing + 50% at 30 DAS + 25% at boot leaf stage returned significantly higher gross returns (Rs. 61008/ha) except net (Rs.3108/ha) and B:C (1.71) ratio as compared to other treatments, it was significantly comparable with treatment T_4.

The genotype CSH 16 expressed significantly greater amount of gross (58947/ha), net (29516/ha) and B:C ratio (1.66) as compared to CSV 20, sowing to higher grain yield.

Interaction

Interaction effect found to be non significant.

Ancillary data

Three Split application of nitrogen i.e N3 recorded higher plant height and 100 seed weight over rest of treatment (Table 2)

In conclusion, nitrogen should be applied in three (N_3) split doses to *kharif* sorghum to produce higher grain and fodder yield. Hybrid CSH 16 produces more grain than fodder yield recorded by CSV-20.

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