

Effect of Irrigation Schedule and Nitrogen Management on Productivity, Profitability of Summer Pearl Millet Grown Under Clay Soils of South Gujarat

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Abstract – A field experiment was carried out at Soil and Water Management Research Farm, Navsari, on clayey soils during summer season of 2016 to study the “Effect of irrigation schedule and nitrogen management on productivity, profitability of summer pearl millet grown under clay soils of South Gujarat”. Irrigation schedule at 0.8 IW: CPE ratio recorded significantly higher growth and yield attributes viz., plant height, leaf area index, number of effective tillers plant⁻¹, length and girth of ear head, grain weight head⁻¹, test weight as well as yields of pearl millet, but it remained at par with treatment Irrigation schedule at 1.0 IW: CPE ratio. Most of all the attributes and yields of pearl millet recorded significantly higher under higher level of nitrogen i.e. 120 kg N ha⁻¹, which was at par with 100 kg N ha⁻¹. Application of 1% foliar spray of banana pseudo stem enrich sap at tillering and flag leaf stage recorded significantly higher growth as well and yield attributing characters and yields of summer pearl millet. The maximum water use efficiency was recorded under irrigation scheduling at 0.8 IW: CPE.

Keywords – Banana Pseudo Stem Sap, Irrigation Schedule, Nitrogen Management, Summer Pearl Millet.

I. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is the staple cereal in arid and semi-arid regions of the country. It is the only cereal crop that is capable of producing a reliable yield under the marginal environments and simultaneously responds to high management conditions. Water management studies have become an important aspect of research conducted in the field of irrigated crops. Among the different approaches to scheduling of irrigation, climatological approaches based on irrigation water (IW) : cumulative pan evaporation (CPE) ratio is found to be the most appropriate as it integrates all the weather parameters giving their natural relation in a given soil-water plant continuum. Fertilizer plays essential role in summer pearl millet production. Nitrogen is one of the decisive nutrient play essential roles in summer pearl millet production. The present invention provides bio-enriched organic fertilizer composition intended to minimize use of chemical fertilizer. Navsari Agricultural University had innovative idea to extract sap from scutcher waste generated during the process of fiber extraction from pseudo stem of banana. So, the information regarding water requirement and irrigation scheduling as well as use of nitrogen and banana pseudo stem sap for summer pearl millet crop is lacking for the clayey soil of south Gujarat agro climatic zone. Therefore, the present experiment was planned.

II. MATERIALS AND METHODS

A field experiment was conducted during summer season of 2016 at Soil and Water Management Research Farm, Navsari Agricultural University, Navsari. The texture of the experimental soil was clayey with bulk density 1.44 g cm³, field capacity 35.2 %, permanent wilting point 18.2 %, pH 7.87, electrical conductivity 0.32 dS m⁻¹, medium in available nitrogen (275 kg ha⁻¹), phosphorus (35 kg ha⁻¹) and fairly rich in available potassium (352 kg ha⁻¹). The experiment was laid out in split plot design with four replications. There were 18 treatment combinations comprised of 3 levels of irrigation scheduling [0.6, 0.8 and 1.0 IW: CPE ratio] in main plots, 3 levels of nitrogen (80, 100 and 120 kg ha⁻¹ and 2 levels of banana pseudo stem enrich sap [control and 1 % foliar spray of banana pseudo stem enrich sap spray at tillering and flag leaf stage] in a sub plots. Pearl millet variety GHB 558 was transplanted on 11th February, 2016 at row spacing of 45 cm with seed rate of 4 kg ha⁻¹. Crop was fertilized as per respective treatments in which 50% N in the form of urea and full dose of phosphorus 60 kg P₂O₅ ha⁻¹ as a basal dose before transplanting for all the treatments. Remaining 50% N was applied at an interval of 30 days after transplanting as per the treatments. The irrigation treatments were imposed after transplanting of crop and common irrigation was given immediately after transplanting. The cumulative pan evaporation values were calculated from daily pan evaporation measured with the help of open pan evaporimeter installed at meteorological observatory. The quantity of irrigation water applied in surface flooding was measured by 7.5 cm head Parshall flume. A fixed depth of 60 mm irrigation water was applied to each treatments based on IW: CPE ratio of 0.6, 0.8 and 1.0. Spraying of 1 % banana pseudo stem enrich sap at tillering and flag leaf stage with a hand operated knapsack sprayer in the morning time under dry and clear sun condition.

III. RESULTS AND DISCUSSION

Effect of Irrigation Schedule

It is evident from the data presented in Table 1 that Irrigation schedule at 0.8 IW: CPE ratio (I₂) recorded significantly higher growth and yield attributing characters viz., plant height, LAI, number of effective tillers, length and girth of ear head, grain weight head⁻¹ and test weight as well as grain and straw yields of summer pearl millet, but it remained statistically at par with treatment I₃ (1.0

IW: CPE ratio). It was interesting to note that treatment I₂ (0.8 IW: CPE ratio) increased in grain yield by 28.96 and 6.73 % over treatment I₁ and I₃, respectively. The increased in straw yield under treatment I₂ (0.8 IW: CPE ratio) to the tune of 27.80 and 6.41 % over treatments I₁ and I₃, respectively. Increase in irrigation frequency tended to increase consumptive use of water, which provided congenial condition throughout the growth period of the crop. Moreover, moisture stress was not experienced by crop during vegetative and reproductive growth periods, resulted in improvement in growth and yield attributing characters, thereby, produced higher grain and straw yields. These results are in line with those reported by Khafi *et al.* (2011) and Patel *et al.* (2013).

Effect of Nitrogen Management

An appraisal of data (Table 1) showed that significantly higher plant height, LAI, number of effective tiller plant⁻¹, length as well as girth of ear head, grain weight head⁻¹ and test weight were recorded under higher level of nitrogen *i.e.* 120 kg ha⁻¹ (N₃), however it was at par with 100 kg N ha⁻¹ (N₂). A probable reason for that nitrogen enhances the development of strong cell wall and therefore, stiffer straw which might be resulted into profuse tillers. The higher photosynthesis resulted in better development in the yield attributes. Higher yield attributes in treatment may be due to regular and readily availability of nutrients in this treatment due to this better vegetative growth of the plant. Thus, all the yield attributes were remarkably improved and gave significant response of nitrogen application to the pearl millet crop.

Among the nitrogen levels, higher level of nitrogen *i.e.* 120 kg ha⁻¹ (N₃) produced significantly higher grain and straw yields of summer pearl millet, which was at par with treatment N₂ (100 kg N ha⁻¹). The increased in grain yield under treatment N₃ were 668 and 178 kg ha⁻¹ over treatments N₁ and N₂, respectively. It was interesting to note that treatment N₃ (120 kg N ha⁻¹) increased the straw yield by 20.19 and 2.69 % over treatment N₁ and N₂, respectively. Nitrogen application increases the activity of cytokinin in plant which leads to the increased cell-division and elongation. This resulted in better development in terms of growth and yield attributing characters which was returned in higher yields. These results are also in agreement with findings of Piri and Tavassoli (2012) and Prakash *et al.* (2014).

Effect of Banana Pseudo Stem Sap:

Applications of 1% foliar spray of banana pseudo stem enrich sap at tillering and flag leaf stage (B₂) recorded significantly higher plant height and also leaf area index. The yield attributes like number of effective tiller plant⁻¹, length and girth of ear head, grain weight head⁻¹ and test weight recorded significantly higher under application of 1% banana pseudo stem enrich sap spray at tillering and flag leaf stage than control treatment. Banana pseudo stem enriched sap contains essential plant nutrients along with growth regulators like GA₃, cytokinin and micronutrients, which boost up the plant growth. Grain and straw yields of summer pearl millet also remarkably higher under treatment of 1% banana pseudo stem enrich sap treatment as compared to control. The increased in grain yield due to

the application of 1% banana pseudo stem enrich sap to the tune of 15.02 %. In response to its positive effect in enhancing the growth and yield attributes of the summer pearl millet crop and conclusive effect on yields. Similar results are in agreement with finding of Shinde *et al.* (2015) and Anon., (2017).

Interaction Effect

Among the interaction effect of irrigation schedule, nitrogen and banana pseudo stem sap (I x N x B) for grain yield were found significant. Data furnished in Table 2 revealed that treatment combination I₂N₃B₂ (irrigation schedule at 0.8 IW:CPE ratio, nitrogen @ 120 kg N ha⁻¹ and 1% banana pseudo stem enrich sap) recorded significantly higher grain yield, but it remained at par with treatment combination I₂N₂B₂.

Water use Efficiency

The maximum water use efficiency was recorded under irrigation scheduling at 0.8 IW: CPE during summer season grown pearl millet.

Economics

The results indicated that net realization was increased with increase in irrigation levels from 0.6 to 1.0 IW: CPE ratio. Net return and B: C ratio increased with the increase in irrigation levels because more number of irrigation produced more grain and straw yields and directly effect on economics.

Among the different levels of nitrogen indicated that treatment N₃ (120 kg N ha⁻¹) was found superior by recording the maximum value of net returns and BCR followed by treatment N₂ (100 kg N ha⁻¹).

Application of 1% banana pseudo stem enrich sap (B₂) was found superior by obtained the higher net returns and BCR than control.

IV. CONCLUSION

In the light of the results obtained from this investigation, it is concluded that for getting higher yields and economics from the summer pearl millet crop irrigated at 0.8 IW: CPE, applied 100 kg N ha⁻¹ and spray of 1% of banana pseudo stem enrich sap at tillering and flag leaf stage in clayey soil under South Gujarat condition.

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Table 1. Effect of different treatments on growth, yield and economics of summer pearl millet.

Treatment	Plant height at harvest (cm)	Leaf area index at 60 DATP	No. of effective tillers plant ⁻¹	Length of ear head (cm)	Girth of ear head (cm)	Grain weight ear head ⁻¹ (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Net return (Rs.ha ⁻¹)	BCR	WUE (kghamm ⁻¹)
Irrigation schedule (I)											
I ₁ :0.6 IW:CPE	138.6	2.44	2.6	20.9	9.5	40.00	2338	3726	25958	2.15	7.79
I ₂ :0.8 IW:CPE	149.9	2.79	2.9	23.0	9.8	47.12	3015	4762	38998	2.66	8.37
I ₃ :1.0 IW:CPE	143.6	2.53	2.8	22.7	9.7	45.41	2825	4475	34197	2.40	6.73
C.D. (P = 0.05)	8.42	0.14	0.22	1.07	0.22	1.71	225	303	-	-	-
Nitrogen levels (N)											
N ₁ : 80 kg ha ⁻¹	138.5	2.32	2.5	20.5	9.4	41.08	2340	3844	30141	2.60	-
N ₂ : 100 kg ha ⁻¹	145.5	2.68	2.8	22.9	9.7	45.37	2830	4499	39592	3.07	-
N ₃ : 120 kg ha ⁻¹	148.2	2.76	2.9	23.3	9.8	46.08	3008	4620	42610	3.20	-
C.D. (P = 0.05)	5.60	0.10	0.16	0.60	0.12	0.91	197	221	-	-	-
Banana pseudo stem sap (B)											
B ₁ :Control	138.7	2.42	2.6	21.4	9.5	43.02	2536	4181	33741	2.74	-
B ₂ :1% Banana pseudo stem sap	149.3	2.76	2.9	23.1	9.8	45.33	2917	4461	38677	2.81	-
C.D. (P = 0.05)	4.57	0.67	0.13	0.48	0.10	0.74	161	180	-	-	-

Table 2. Interaction effect of I x N x B on grain yield of summer pearl millet (kg ha⁻¹)

Treatment	Nitrogen levels (N)					
	N ₁		N ₂		N ₃	
	Banana pseudo stem sap (B)					
Irrigation schedule (I)	B ₁	B ₂	B ₁	B ₂	B ₁	B ₂
I ₁	2176	2224	2242	2368	2414	2610
I ₂	2364	2699	2576	3750	2580	4125
I ₃	2223	2357	2975	3075	3275	3050
S. Em. ±	169					
C.D. (P=0.05)	483					