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EFFECT OF SOWING TIME AND NUTRIENT MANAGEMENT ON GROWTH, YIELD AND QUALITY OF PEARL MILLET CV. DHANSHAKTI UNDER RAINFED CONDITION

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Abstract: *A field experiment entitled "Effect of sowing time and nutrient management on growth, yield and quality of pearl millet cv. Dhanshakti under rainfed condition" was carried out at College of Agriculture, Dhule, Dist Dhule, Maharashtra, India during the kharif season of year 2013. The experiment was laid out in Factorial Randomized Block Design with three replications. The treatment comprised of three sowing time and four nutrient management treatments as per STCR. Significantly higher number of leaves per plant, leaf area per plant, dry matter per plant, earhead length (cm), earhead girth (cm), grain weight per earhead (g), 1000 seed weight (kg), grain yield (kg ha^{-1}) and grain yield (kg ha^{-1}) were found in 26th Meteorological Week (MW). However, it was found at par with 28th Meteorological Week (MW). The treatment Fertilizer as per STCR with 35 q ha^{-1} yield target was found significantly the highest in all yield and yield attributing parameters of pearl millet over rest of the treatments. Significantly the highest protein yield (kg ha^{-1}) was found in Fertilizer as per STCR with 35 q ha^{-1} yield target (322.126 kg ha^{-1}) over rest of the treatment and non significant in respect to iron (ppm) and protein (%). Significantly the highest available nitrogen (170.04 kg ha^{-1}), phosphorus (15.37 kg ha^{-1}) and potassium (544.38 kg ha^{-1}) were observed in Fertilizer as per STCR with 25 q ha^{-1} yield target over all treatments. Suitable time of sowing for pearl millet cv.Dhanshakti was 26th MW under rainfed condition, fertilizer applied as per Soil Test Crop Response (STCR) with 35 q ha^{-1} yield target secured the maximum growth and yield of pearl millet and also higher net monetary returns.*

Key words: *Pearl millet, Nutrient Management, Economics, Sowing time and Rainfed condition.*

Introduction

Pearl millet is the third most important cereal staple food crop in India. It is often referred as "The poor man's food". Pearl millet is the most widely cultivated cereal in India after rice and wheat. The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which account for more than 90% of pearl millet acreage in country. Pearl millet can easily provide economical grain yield (600 – 700 kg ha-1) under marginal and low management conditions with the additional ability to produce a grain yield of 4-5 t ha-1 when hybrids of 80-85 days maturity are grown in summer season crop under irrigated and high fertility conditions.

Sowing very early in the season may not be advantageous. Also delayed sowing invariably reduces crop yield. Sowing the crop at optimum time increases yield due to suitable environment at all the growth stages of the crop. Flowering is induced after sufficient vegetative growth. Moisture stress or dry spells may be avoided during critical growth stages. Therefore, optimum sowing time plays an important role in crop production. As Dhanshakti (ICTP 8203 Fe 10-2) is newly released cultivar, it is crucial to suggest the suitable time of sowing for its better performance.

Soil test based application of plant nutrient helps to realize higher response ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization (Rao and shrivastava, 2002). Location-specific fertilizer

recommendations are possible for soils of varying fertility, resource conditions of farmers and levels of targeted yield for similar soil classes and environment (Ahmed *et al*, 2002; Bera *et al*, 2006). Hence it is necessary to have information on the optimum doses of fertilizers and organics based on soil testing, nutrient uptake and efficiency of added nutrients by the crop to develop a guideline for judicious application of fertilizer under integrated nutrient management system. High cost of the fertilizer poses a vital problem to use them efficiently and economically. With increasing in the cost of fertilizers, it is imperative to reduce the quantity of fertilizer and increase their efficiency by way of getting higher yields per unit area. In this regard, targeted yield approach provided a basis for such approach which takes into account available nutrient in the soil and crop needs (Ramamoorthy et al, 1967 and Kanwar, 1971.) The prevalent practice of application of general dose of fertilizer for a crop irrespective of soil type needs to be given fresh thinking. In the present philosophy of targetted yield approach, it is now possible to make fertilizer recommendations to farmers considering their financial conditions and for the targeted yield of a crop.

Pearl millet is important *kharif* cereal crop of scarcity zone of Maharashtra. The meger information is available on sowing time for pearl millet and effect of nutrient management as per Soil Test Crop Response (STCR) approach on growth, yield and quality of pearl millet on medium soil type and hence, the present investigation was planned with the following objectives.

1. To suggest the suitable time of sowing for pearl millet crop variety under study.
2. To study the effect of nutrient management on growth, yield and quality of pearl millet.
3. To study the interaction effect between time of sowing and nutrient management.
4. To work out economics of different treatments.

Materials and Methods

The field experiment was carried out at Agronomy Farm, College of Agriculture, Dhule, Dist Dhule, Maharashtra, India during the *kharif* season of year 2013. The topography of the experimental field was uniform and leveled. The soil was well drained and clay in texture and slightly alkaline in reaction. The soil was very low in available nitrogen, low in available phosphorus and very high in available potassium. The soil was free from any kind of salinity or sodicity hazards.

The experiment was laid out in Factorial Randomized Block Design with three replications. The treatment comprised of three sowing time and four nutrient management treatments as per STCR. The treatments were assigned at random in each replication. The statistical analysis of the data was done by statistical method known as "Analysis of variance" appropriate for the strip plot design (Panse and Sukhatme, 1967).

The pearl millet seed (cv.Dhanshakti) was sown by drilling in different meteorological week *viz*. D_1 (26^{th} MW), D_2 (28^{th} MW) and D_3 (30^{th} MW) at a row spacing of 45 cm x 15 cm. The plant to plant distance was maintained by thining and four nutrient management treatments as per STCR *viz*. F_1: 100 % RDF ha^{-1}, F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target, F_3: Fertilizer as per STCR with 30 q ha^{-1} yield target and F_4: Fertilizer as per STCR with 35 q ha^{-1} yield target. Two hand weeding and two intercultural operations were carried out in each sowing date to keep experimental plot free from weeds. The recommended fertilizer dose of 50 kg N ha^{-1}, 25 kg P_2O_5 ha^{-1} and 25 kg K_2O ha^{-1} was applied. Recommended plant protection measures were followed in the experimental field. The crop was harvested at maturity on 27 Sept, 2013 (D_1), 09 Oct, 2013 (D_2), and 16 Oct, 2013 (D_3).

Results and Discussion

Effect of treatments on yield and yield attributes

The statistically analyzed data on yield and yield attributes parameters of pearl millet are presented in Table 1

Effect of Sowing time:

The perusal of data indicated that significantly higher number of leaves per plant, leaf area per plant, dry matter per plant, earhead length

(cm), earhead girth (cm), grain weight per earhead (g), 1000 seed weight (kg), grain yield (kg ha^{-1}) and grain yield (kg ha^{-1}) were found in (D_1) 26th Meteorological Week (MW). However, it was found at par with (D_2) 28th Meteorological Week (MW) and significantly the highest plant height and number of effective tillers per plant of pearl millet were observed in (D_1) 26th Meteorological Week (MW) (205.48 cm, and 1.33) over rest of the treatments. The number of plants per hectare was found to be non-significant.

The data on quality parameters of pearl millet are presented in Table 3 revealed that the significantly higher protein yield (kg ha^{-1}) was found in (D_1) 26th Meteorological Week (MW) (299.56 kg ha^{-1}). However, it was found at par with (D_2) 28th Meteorological Week (MW) (284.65 kg ha^{-1}) and non significant in respect to iron (ppm) and protein (%).

The available nitrogen, phosphorus and potassium (kg ha^{-1}) after crop harvest were found to be non significant.

Increase in leaf area probably due to early sown crop have enjoyed maximum light which might be the reason for enhanced leaf area along with favourable climatic conditions during various crop growth stages, which reflected into better growth. Similar results were observed by Andhale et al.(2007), Upadhay et al.(2001), Patel and Patel (2002) and Patel et al. (2004).

Leaf dry matter higher due to early sown pearl millet crop might have enjoyed the favorable climate at which increased the plant height, number of leaves and leaf area. This accumulates more photosynthates and increased the dry matter production. The results are corroborative to those reported by Andhale et al.(2007), Upadhay et al.(2001), Patel and Patel (2002) and Patel et al. (2004).

Effect of nutrient manegement:

The treatment (F_4) Fertilizer as per STCR with 35 q ha^{-1} yield target was found significantly the highest in all yield and yield attributing parameters of pearl millet over rest of the treatments. The number of plants per hectare was found to be non-significant.

Significantly the highest protein yield (kg ha^{-1}) was found in (F_4) Fertilizer as per STCR with 35 q ha^{-1} yield target (322.126 kg ha^{-1}) over rest of the treatment and non significant in respect to iron (ppm) and protein (%).

Significantly the highest available nitrogen (170.04 kg ha^{-1}), phosphorus (15.37 kg ha^{-1}) and potassium (544.38 kg ha^{-1}) were observed in F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target over all treatments.

The leaf area increase due to increased number of leaves and growth of pearl millet by proper nutrition through STCR approach resulted in more leaf area. The results are in conformity to those reported by Pawan Kumar *et al.* (2008).

Higher leaf dry matter due to the increased and required nutrition made available through STCR approach for higher targeted yield of pearl millet enjoyed the more nutrient resulted in more accumulation of photosynthates and increased the dry matter. The results are conformity to those reported by (Kumar *et al.*, 2004; Singh *et al.*, 2008 and Mishra *et al.*, 2010).

The significant increase in test weight may be attributed to better grain filling due to improved nutrient supply. The results are corroborative to those reported by Apoorva et al. (2010).

Increased the grain and fodder yield be due to congenial climatic condition during early sowing play a important role which reflected better crop growth and development of yield attributes. The combine effect of growth and yield attributes resulted in more dry matter accumulation and increased the grain and fodder yield. These findings are similar to those reported by Andhale et al. (2007), Upadhyay et al. (2001), Patel and Patel (2002) and Patel et al. (2004). Also due to increase in fertilizer dose and balanced fertilization through STCR increased crop yield probably by making more nutrients available to plants which in turn increased crop growth, yield attributes which increased the

grain and fodder yield (Kumar *et al.*, 2004; Singh *et al.*, 2008 and Mishra *et al.*, 2010).

The higher protein yield because of increased N content in grain which might be the result of increased availability of nitrogen to plants. Higher nitrogen in grain is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. The findings of present investigation are in agreement with those of Mundra *et al.* (2002) and Meena and Gautam (2005).

Interaction:

The interaction between Sowing time and nutrient manegement of of pearl millet were found found to be non-significant in respect to yield and yield attributing parameters, quality parameters and avilable NPK status.

Economics of pearl millet:

The details of income and expenditure along with net returns and benefit: cost ratio under various sowing time and nutrient management treatments are presented in Table 5.

Effect of sowing time

The sowing of pearl millet at 26th MW (D1) recorded higher cost of cultivation, gross monetary returns, net monetary returns and B:C ratio (₹24755, ₹ 42978 ₹ 18223 and 1.73) followed by its sowing at 28th MW (D_2) (₹ 24535, ₹ 41248 ₹ 16713 and 1.68). The values of gross monetary returns, net monetary returns (₹ 23780, ₹ 34728, ₹ 10948 and 1.46) were recorded when it was sown at 30th MW (D_3).

Effect of nutrient management

The pearl millet fertilized with STCR at 35 q ha^{-1} yield target (F_4) recorded higher cost of cultivation, gross monetary returns and net monetary returns (₹ 29514, ₹ 43746 and ₹ 14232) than rest of the nutrient management treatments and it was followed by nutrient management at 30 q ha^{-1} yield target (F_3) (₹ 28262, ₹42132 and ₹13870) and 25 q ha^{-1} yield target (F_2) (₹ 26481, ₹ 35142, ₹ 8661). The lowest cost of cultivation was observed due to nutrient management at 100 % RDF ha^{-1} (F_1) (₹26172, ₹ 37586 and ₹ 11414). The highest B:C ratio was observed in nutrient management at 30 q ha^{-1} yield target (F_3) (1.49) followed by nutrient management at 35 q ha^{-1} yield target (F_4) (1.48), nutrient management at 100 % RDF ha^{-1} (F_1) (1.43) and lowest in nutrient management at 25 q ha^{-1} yield target (F_2) (1.32.)

Comparison of STCRC and actual grain yield:

The yield targets of 25, 30 and 35 q ha^{-1} with respect to treatment F_2, F_3 and F_4, respectively not obtained (Table 2). This might be due to the pearl millet cv.Dhanshakti was variety. This might be due to genetically potential of this cultivar.

Conclusion:

1. In the light of result obtained from this investigation, it is concluded that the suitable time of sowing for pearl millet cv.Dhanshakti was 26th MW under rainfed condition for securing grain and fodder yield and net return.
2. The fertilizer applied as per Soil Test Crop Response (STCR) with 35 q ha^{-1} yield target (F_4) secured the maximum growth and yield of pearl millet.
3. There was no significant difference in iron containt of pearl millet grains due to date of sowing or nutrient management treatments.
4. The interaction effect between time of sowing and different nutrient management treatments were found non significant for all the observation under study.
5. Though the net monetary returns obtained from nutrient management as per Soil Test Crop Response (STCR) with 35 q ha^{-1} yield target (F_4) was higher, the B:C ratio was higher with 30 q ha^{-1} yield target (F_3).

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Table 1: Yield and yield attributing parameters of pearl millet as influenced by different sowing time and nutrient management treatments

Treatment	No of plant ha^{-1}	Plant height (cm)	No of leaves plant ha^{-1}	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$	No of effective tillers $plant^{-1}$	Earhead length (cm)	Earhead girth (cm)	No. of grains $earhead^{-1}$	Grain weight $earhead^{-1}$ (g)	1000 seed weight (g)	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	HI (%)
Sowing time														
D_1: 26th Meteorological Week (MW)	145258	205.48	9.31	92.59	129.06	1.33	21.26	9.39	2231.88	28.77	11.58	2756.79	6009.72	31.63
D_2: 28th Meteorological Week (MW)	144864	202.23	9.08	88.76	127.31	1.18	20.65	9.12	2185.57	27.33	11.33	2645.02	5789.30	31.40
D_3: 30th Meteorological Week (MW)	144273	192.22	8.42	80.29	110.95	1.02	18.95	8.49	1938.88	24.87	9.33	2224.97	4932.32	31.11
SE ±	**1099.38**	**3.49**	**0.20**	**1.94**	**3.93**	**0.04**	**0.40**	**0.09**	**51.24**	**0.74**	**0.30**	**56.91**	**198.62**	
CD at 5 %	**NS**	**10.25**	**0.57**	**5.70**	**11.52**	**0.12**	**1.17**	**0.27**	**150.27**	**2.18**	**0.88**	**166.92**	**582.54**	
Nutrient management: [Fertilizer (F)]														
F_1: 100 % RDF ha^{-1}	144733	197.27	8.67	86.94	115.46	1.11	19.75	8.72	2054.67	26.24	10.33	2401.30	5533.45	30.24
F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target	144295	191.38	8.53	81.22	110.61	0.93	19.00	8.44	1951.20	25.15	9.67	2251.24	4998.90	31.13
F_3: Fertilizer as per STCR with 30 q ha^{-1} yield target	144908	204.04	9.16	89.19	123.72	1.27	20.32	9.06	2135.96	27.29	11.17	2707.27	5752.34	32.17
F_4: Fertilizer as per STCR with 35 q ha^{-1} yield target	145258	207.22	9.37	91.49	139.97	1.40	22.07	9.71	2333.29	29.28	11.83	2809.22	6023.77	31.97
SE ±	**397.05**	**1.26**	**0.07**	**0.70**	**1.42**	**0.01**	**0.14**	**0.03**	**18.50**	**0.27**	**0.11**	**20.55**	**71.73**	
CD at 5 %	**NS**	**3.70**	**0.21**	**2.06**	**4.16**	**0.04**	**0.42**	**0.10**	**54.27**	**0.79**	**0.32**	**60.28**	**210.39**	
Interaction														
SE ±	**2198.76**	**6.99**	**0.39**	**3.89**	**7.85**	**0.08**	**0.80**	**0.19**	**102.47**	**1.49**	**0.60**	**113.82**	**397.25**	
CD at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
General Mean	**144799**	**199.98**	**8.93**	**87.21**	**122.44**	**1.18**	**20.28**	**8.98**	**2118.78**	**26.99**	**10.75**	**2542.26**	**5577.12**	**31.38**

Table 2: Comparison of STCR and actual grain yield values

Treatment	STCR grain yield values (q ha^{-1})	Actual grain yield values (q ha^{-1})	Increase (+) or decrease (-) over STCR (q ha^{-1})
F2: Fertilizer as per STCR with 25 q ha-1 yield target	25.00	22.51	-2.49
F3: Fertilizer as per STCR with 30 q ha-1 yield target	30.00	27.07	-2.93
F4: Fertilizer as per STCR with 35 q ha-1 yield target	35.00	28.09	-6.91

Table 3: Iron (ppm), protein (%) and protein yield (kg ha-1) contain in pearl millet grains as influenced by different sowing time and nutrient management treatments

Treatment	Iron (ppm)	Protein (%)	Protein yield (kg ha^{-1})
A. Sowing time: (D)			
D_1: 26th Meteorological Week (MW)	81.01	10.88	299.56
D_2: 28th Meteorological Week (MW)	80.91	10.70	284.65
D_3: 30th Meteorological Week (MW)	80.51	10.25	228.79
SE ±	**2.78**	**0.32**	**9.33**
CD at 5 %	**NS**	**NS**	**27.35**
B. Nutrient management: [Fertilizer(F)]			
F_1: 100 % RDF ha^{-1}	80.42	10.40	247.79
F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target	80.09	9.93	224.96

F_3: Fertilizer as per STCR with 30 q ha^{-1} yield target	81.25	10.72	289.15
F_4: Fertilizer as per STCR with 35 q ha^{-1} yield target	81.48	11.38	322.12
S. E. (m) +	**1.00**	**0.12**	**3.37**
C. D. at 5 %	**NS**	**NS**	**9.88**
C. Interaction			
S. E. (m) +	**5.55**	**0.64**	**18.65**
C. D. at 5 %	**NS**	**NS**	**NS**
General mean	**80.81**	**10.61**	**271.00**

Table 4: Effect of sowing time and nutrient management treatments on available nitrogen (kg ha^{-1}), phosphorus (kg ha^{-1}) and potassium (kg ha^{-1}) status of soil after harvest of pearl millet

Treatments	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
A. Sowing time: (D)			
D_1: 26th Meteorological Week (MW)	153.73	12.59	515.97
D_2: 28th Meteorological Week (MW)	155.28	13.79	518.39
D_3: 30th Meteorological Week (MW)	159.68	13.88	521.94
SE ±	**5.30**	**0.42**	**11.18**
CD at 5 %	**NS**	**NS**	**NS**
B. Nutrient management: [Fertilizer(F)]			
F_1: 100 % RDF ha^{-1}	161.57	13.74	530.91
F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target	170.04	15.37	544.38
F_3: Fertilizer as per STCR with 30 q ha^{-1} yield target	153.03	12.61	505.17
F_4: Fertilizer as per STCR with 35 q ha^{-1} yield target	140.28	11.96	494.61
S. E. (m) +	**1.91**	**0.15**	**4.04**
C. D. at 5 %	**5.61**	**0.44**	**11.84**
C. Interaction			
S. E. (m) +	10.59	0.84	22.35
C. D. at 5 %	**NS**	**NS**	**NS**
General mean	**156.23**	**13.42**	**518.77**

Table 5: Economics of pearl millet as influenced by different sowing time and nutrient management treatments

Treatment	Cost of cultivation (ha^{-1})	Gross monetary returns (ha^{-1})	Net monetary returns (` ha^{-1})	B:C ratio
A. Sowing time: (D)				
D_1: 26th Meteorological Week (MW)	24755	42978	18223	1.73
D_2: 28th Meteorological Week (MW)	24535	41248	16713	1.68
D_3: 30th Meteorological Week (MW)	23780	34728	10948	1.46
B. Nutrient management: [Fertilizer (F)]				
F_1: 100 % RDF ha^{-1}	26172	37586	11414	1.43
F_2: Fertilizer as per STCR with 25 q ha^{-1} yield target	26481	35142	8661	1.32
F_3: Fertilizer as per STCR with 30 q ha^{-1} yield target	28262	42132	13870	1.49
F_4: Fertilizer as per STCR with 35 q ha^{-1} yield target	29514	43746	14232	1.48