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Effect of Sowing Time and Establishment Techniques on Growth and Yield of Prosomillet (*Panicum miliaceum* L.) under Lateritic Soil of Konkan

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Field experiment was conducted at College of Agriculture, Dapoli, during *kharif* 2015, to study the effect of sowing time and establishment techniques on growth and yield of proso millet (*Panicum miliaceum* L.) under lateritic soil of Konkan. The present investigation was carried out in strip plot design with three replications. The vertical strip comprised of three sowing time *viz.,* 23rd meteorogolical week (MW), 25th MW and 27th MW and horizontal strip constituted four establishment techniques viz., drilling at 20 cm, broadcasting, transplanting at 20 cm x 15 cm and *awatni* (a traditional method of cultivation in which seedling are uprooted from nursery and planted by throwing it randomly).The results indicated that, sowing of proso millet on 25th MW produced maximum and significantly higher grain (0.926 t ha^{-1}) and straw (3.30 t ha^{-1}) yield over rest of the sowing times. Transplanting of proso millet produced maximum and significantly higher grain (1.015 t ha^{-1}) and straw (3.621 t ha^{-1}) yield over rest of the establishment techniques which was followed by awatni method. The nitrogen, phosphorus and potassium content in grain and straw of proso millet were recorded significantly higher under 25th MW sowing over rest of the sowing times. The uptake of nitrogen, phosphorus and potassium in grain, straw and their total was significantly higher under 25th MW sowing over 23rd MW and 27th MW sowing times. Transplanting technique recorded higher nitrogen (1.32 and 0.33%), phosphorus (0.25 and 0.22%) and potassium (0.26 and 3.43%) content in grain and straw respectively. The uptake of nitrogen (13.54 and 11.94 kg ha^{-1}), phosphorus (2.56 and 7.96 kg ha^{-1}) and potassium (2.26 and 124.20 kg ha^{-1}) in grain and straw was higher in transplanting technique. Maximum grain and straw yield with highest gross return (Rs. 36405.00 ha^{-1}), net return (Rs. 5936.00 ha^{-1}) and B:C ratio (1.19) was obtained when the proso millet sown on 25th MW with transplanting technique.

(***Key words:*** *Sowing time, establishment techniques, yield, nutrient uptake, economics)*

Proso millet (*Panicum miliaceum* L.) locally known as *vari*, is an important staple food grain in semi-arid areas where hardly any cereal crop can be grown. In India small millet is cultivated over an area of 0.0719 million ha with total production of 0.435 million tonnes during 2012-13 (Anonymous, 2013). In Maharashtra, the largest area is found in Konkan region comprising Raigad, Thane, Sindhudurg and Ratnagiri districts. It is an important minor millet and being a short duration crop (110-115 days) with relatively low water requirement, it escapes drought period. The seeds are rich source of protein (12-13%) and have long storability under ambient conditions and hence, suitable as famine reserve. It is rich in lysine as high as 4.6% of the total proteins. In addition to protein, it also contains about 1.1% crude fat, 68.9% carbohydrates, 2-3% minerals and 2.2 % crude fiber.

In *Konkan* region of Maharashtra with high rainfall and undulating topography, it is cultivated on very light soils on hill slopes where other crops cannot be grown successfully. Similarly, no attention is paid to sow it timely to provide suitable growing environment for higher yield. On the contrary, sowing dates were identified as important management options to optimize yield of crop. Method of sowing is another important agronomic factor affecting the productivity of crop. Appropriate sowing method is the important non-monetary input in crop production, which affects the crop growth, yield and quality to greater extent. Method of crop establishment is also important for efficient use of all available resources for growth as it provides optimum growing condition. Proso millet is mainly grown by drilling, broadcasting, and transplanting and *awatni* methods. In *Konkan* region, proso millet is cultivated by transplanting and *awatni* methods. *Awatni* is a traditional method of proso millet cultivation in which seedling are uprooted from nursery and planted by throwing it randomly. Therefore, the establishment of crop is very

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slow in *awatni* method as a result; the yield of crop is reduced to greater extent. In the broadcasting method initial growth rate is very slow, as a result higher competition for nutrient is the major drawback of this practice.

The systematic study on the performance of proso millet grown by direct seed sowing in comparison with *awatni* (Farmers practice), broadcasting and recommended transplanting is not conducted in this region. With this view, the field experiment was carried out to study the effect of sowing time and establishment techniques on growth and yield of proso millet (*Panicum miliaceum* L.) under lateritic soil of *Konkan*.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy farm, College of Agriculture, Dapoli. Dist. Ratnagiri during *Kharif* 2015. The soil of the experimental plot was sandy clay loam in texture, low in available nitrogen (247.43 kg ha^{-1}) and phosphorus (10.92 kg ha^{-1}) and moderately high in available potassium (229.62 kg ha^{-1}), very high in organic carbon (11.57) and moderately acidic in reaction (pH 5.51).The experiment was laid out in a strip plot design. The vertical strip comprised three sowing times(23rd MW-4 to 10 June, 25th MW -18 to 24 June and 27th MW- 2 to 8 July) and horizontal strip consisted of four establishment techniques (Drilling at 20 cm, broadcasting, transplanting at 20 cm x 15 cm and *awatni*). Thus there were 12 treatment combinations replicated thrice. The net plot size was 3.8 m x 3.0 m. The variety *Vari No.10* was used for sowing. Seed rate used for drilling was 8 kg ha^{-1}, for broadcasting 10 kg $ha^{-1}$and for transplanting 3.0 kg ha^{-1}. Seeds were treated with thiram @ 3 g kg^{-1} of seeds, before sowing. The line sowing of seeds was carried out at 20 cm spacing in drilling method. The broadcasting of seeds was done on the same day of the nursery sown for the transplanting and *awatni* method. Transplanting of proso millet was done by using 30 days old seedling. Two seedlings $hill^{-1}$ were transplanted at 20 x 15 cm spacing by preparing hole with the help of *thomba*. In *awatni* method, 30 days old, healthy and vigorous seedlings were uprooted and transplanted by broadcasting randomly in the field as per the layout. The necessary plant protection methods were carried out and growth and yield observations were recorded. The data was analysed statistically by opting standard procedures as given by Panse and Sukhatme (1997).

RESULTS AND DISCUSSIONS

Effect of sowing time and establishment techniques on growth parameters

The data pertaining to the growth parameters *viz*. plant height (cm), number of tillers per meter, dry matter (g m^{-2}) of proso millet as influenced by various treatments is presented in Table 1. Perusal of data showed that significantly highest plant height (123.83 cm), number of tillers (107) and dry matter weight (583.58 g) was recorded under the treatment 25th MW sowing over rest of the sowing times i.e. 23rd MW and 27th MW sowings.

Proso millet under transplanting method of establishment recorded significantly highest number of tillers (110.33) and dry matter weight (782.11 g) over drilling and broadcasting technique of establishment and at par with *awatni* (105.78 and 759.6, respectively) technique. This was due to congenial climatic conditions for proso millet crop throughout the growth period compared to other sowing dates. These effects were due to better soil and climatic conditions like soil temperature, soil moisture as well as photoperiod available during initial phase, which favours better photosynthetic activity due to abundant light and moisture. This influenced better source i.e. more number of leaves, tiller and height throughout growing period. Similar results were found by Thorat *et al.* (2009) in rice crop.

Effect of sowing time and establishment techniques on yield attributes and yield

The data pertaining to the yield and yield parameters *viz*. number of panicles per m^{-2}, length of panicle (cm), grain and straw yield (t ha^{-1}) of proso millet as influenced by various treatments are presented in Table 1. Significantly highest number of panicles (95.33), length of panicle (31.94 cm), grain yield (0.926 t ha^{-1}) and straw yield (3.30 t ha^{-1})was recorded under the treatment 25th MW sowing over 23rd MW and 27th MW sowings. This might be due to substantial increased in photosynthetic activity when prosomillet sown on 25th MW, this could be attributed to the appreciably higher yield contributing characters, namely, number of panicles per m^2, length of panicle (cm) and weight of panicle (g). These findings are in conformity with Amanullah *et al.* (2012).

Transplanting method of establishment recorded significantly highest number of panicles (97.11) length of panicles (32.44 cm), grain yield (1.015t ha^{-1}) and straw yield (3.621t ha^{-1}) over drilling, broadcasting and *awatni* techniques of establishment. This might be due to the

Table 1. *Growth, yield and economics under different treatments as influenced by sowing time and establishment techniques*

Treatments	Plant height (cm)	No. of tillers m^{-2}	Dry weight (g)	No. of panicles m^{-2}	Length of panicle (cm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
Sowing times										
S_1- 23rd MW	118.40	102.33	559.83	90.50	30.17	0.907	3.037	30572.83	2336.58	1.08
S_2- 25th MW	123.83	107.00	583.58	95.33	31.94	0.926	3.300	31605.50	3490.58	1.12
S_3- 27th MW	117.50	100.67	554.83	89.50	29.66	0.893	2.927	29955.67	1768.17	1.06
S.Em. ±	0.75	1.12	4.56	0.98	0.28	0.006	0.054	–	–	–
C.D. at 5%	2.31	3.45	14.06	3.02	0.86	0.018	0.166	–	–	–
Establishment techniques										
M_1- Drilling	120.92	101.44	372.22	92.33	30.28	0.860	2.787	28787.78	1909.56	1.07
M_2- Broadcasting	121.72	95.78	350.33	90.56	28.59	0.798	2.676	26900.11	1386.11	1.05
M_3- Transplanting	119.22	110.33	782.11	97.11	32.44	1.015	3.621	34650.44	4166.44	1.14
M_4- *Awatni*	117.78	105.78	759.67	87.11	31.04	0.962	3.268	32507.00	2665.00	1.08
S.Em. ±	2.05	1.64	10.22	1.27	0.37	0.015	0.033	–	–	–
C.D. at 5%	NS	5.06	31.49	3.91	1.13	0.045	0.103	–	–	–
Interaction (S x M)										
S.Em. ±	3.41	3.59	34.00	3.61	0.66	0.060	0.137	–	–	–
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	–	–	–

Table 2. *Nutrient content (%) and uptake (kg ha^{-1}) studies under different treatments*

Treatments	N content (%)		P content (%)		K content (%)		N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Sowing times															
S_1- 23rd MW	1.28	0.30	0.21	0.19	0.21	3.36	10.99	9.31	20.30	1.91	5.96	7.87	1.92	101.25	103.17
S_2- 25th MW	1.30	0.33	0.23	0.22	0.24	3.40	12.25	10.26	22.51	2.01	6.41	8.42	1.98	107.37	109.36
S_3- 27th MW	1.27	0.28	0.20	0.17	0.19	3.34	10.66	8.50	19.16	1.87	5.89	7.76	1.89	98.52	100.41
S.Em. ±	0.01	0.01	0.01	0.01	0.01	0.01	0.13	0.27	0.24	0.03	0.10	0.12	0.01	0.74	0.75
C.D. at 5%	0.02	0.02	0.02	0.03	0.02	0.03	0.39	0.84	0.75	0.08	0.30	0.36	0.04	2.29	1.74
Establishment techniques															
M_1- Drilling	1.28	0.31	0.22	0.20	0.21	3.36	10.40	8.63	19.03	1.78	5.57	7.35	1.70	93.64	95.33
M_2- Broadcasting	1.21	0.26	0.15	0.16	0.16	3.29	8.66	6.41	15.06	1.07	3.95	5.05	1.14	81.23	82.37
M_3- Transplanting	1.32	0.33	0.25	0.22	0.26	3.43	13.54	11.94	25.48	2.56	7.96	10.53	2.66	124.20	126.86
M_4- *Awatni*	1.31	0.32	0.24	0.21	0.23	3.38	12.60	10.45	23.05	2.30	6.86	9.16	2.22	110.45	112.68
S.Em. ±	0.01	0.01	0.01	0.01	0.01	0.01	0.30	0.21	0.32	0.08	0.14	0.22	0.02	0.43	0.42
C.D. at 5%	0.02	0.04	0.02	0.04	0.04	0.02	0.94	0.64	0.99	0.26	0.44	0.68	0.06	1.33	1.30
Interaction (S x M)															
S.Em. ±	0.01	0.02	0.02	0.02	0.06	0.02	0.45	1.53	1.56	0.17	0.68	0.83	0.04	3.92	3.93
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

food material produced by the green leaves during initial growth period which was used by the plant for their structural development that leads to increased number of leaves, height and tillers and thereafter the potential physiological growth attained by the crop plant, whatever food material produced is utilized by crop plant by diverting all food material, to reproductive organs of crop plant that is flower, grain, and ultimately more food material produced which was diverted toward the sink i.e. yield attributing characters and reflected on yield. These findings are in conformity with Narayanswamy *et al.* (1982) in rice.

Effect of sowing time and establishment techniques on economics

Sowing of proso millet on 25th MW gave the highest net returns (Rs. 3490.58) and highest benefit cost ratio of 1.12 (Table 1) over sowing of proso millet on 23rd MW and 27th MW. Similarly transplanting method of establishment gave the highest net returns (Rs. 4166.44) and benefit cost ratio (1.14) as compared to rest of the establishment techniques. The increased net return and benefit cost ratio was mainly due to increased grain and straw yield of proso millet sown on 25th MW by transplanting method.

Effect of sowing time and establishment techniques on nutrient content and uptake

The nitrogen, phosphorus and potassium content (%) in grain and straw was significantly influenced due to sowing times (Table 2). Significantly highest nitrogen (1.30 and 0.33), phosphorus (0.23 and 0.22) and potassium (0.24 and 3.40) content in grain and straw, respectively was observed in 25th MW sowing as compared to 23rd MW and 27th MW sowings. Similarly significantly highest nitrogen (1.32 and 0.33), phosphorus (0.25 and 0.22) and potassium (0.26 and 3.45) content in grain and straw was observed in transplanting method of establishment as compared to rest of the establishment techniques.

The maximum uptake of nitrogen (12.25, 10.26 and 22.51, respectively), phosphorus (2.01, 6.41 and 8.42, respectively) and potassium(1.98, 107.37 and 109.36, respectively) in grain, straw and its total was observed under sowing of proso millet on 25th MW followed by 23rd MW, 27th MW, respectively. In case of establishment techniques, the maximum uptake of nitrogen (13.54, 11.94 and 25.48, respectively), phosphorus (2.56, 7.96 and 10.53, respectively) and potassium(2.66, 124.20 and 126.86, respectively) in grain, straw and its total was observed under transplanting method of establishment. Since uptake is a function of grain and straw yield and their nutrient content, the significant improvement in the content of these nutrients coupled with increased grain and straw yield increased the uptake of nutrients. These finding are in conformity with Pandey *et al.* (2007) in rice crop.

From the above research findings, it can be concluded that for obtaining higher yield and net returns, proso millet crop could be sown on 25th meteorological week (18th June to 24th June) by transplanting technique.

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