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Effects of age of seedling, different macro and micro-nutrients on growth and yield of Proso millet (*Panicum miliaceum* L.) grown during kharif season of Konkan condition

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Abstract

A field experiment was conducted to study the "Effect of age of seedlings at transplanting, different nutrient levels and micronutrient on growth, yield and quality of proso millet (*Panicum miliaceum* L.) grown during kharif season in Konkan region of Maharashtra state. The experiment was laid out in split split plot design with three main plot, two sub plot and four sub sub plot treatments. The main plot treatments comprised three different ages of seedlings of 20, 30 and 40 days old, i.e. A₁, A₂ and A₃ respectively. The two sub plot treatments consisted different nutrient combinations viz., 100% RDF and 125% RDF i.e. N₁ and N₂ respectively. There are four sub sub plot treatments comprise Micronutrient viz. Control, Application of Zinc Sulfate @ 15 kg/ha, application of Ferrous Sulfate @ 15 kg/ha and Combination of Zinc Sulfate and Ferrous Sulfate i.e. M₁, M₂, M₃ and M₄ respectively. The result revealed that, the proso millet crop transplanted with 30 days old seedlings recorded significantly higher growth attributes, grain yield and straw yield over all other treatments. Similarly, higher values of yield attributing characters viz., a number of panicles hill⁻¹, length of panicle (cm), weight of panicle (g), a number of rachis panicle⁻¹ and test weight (g) were recorded under 30 days old seedlings. In Fertilizer levels, 125% RDF through chemical fertilizer treatment recorded significantly higher mean plant height hill⁻¹, number of functional leaves, hill⁻¹, a number of functional tillers hill⁻¹ and plant dry matter accumulation hill⁻¹ than the other treatments. Also, 125% RDF through chemical fertilizer produced significantly higher yields and yield attributes as compared to the rest of the nutrient combinations. In Micronutrients M₄ i.e. Combination of FeSO₄ and ZnSO₄ through soil application treatment recorded significantly higher mean plant height hill⁻¹, a number of functional leaves, hill⁻¹, a number of functional tillers hill⁻¹ and plant dry matter accumulation hill⁻¹ than the other treatments. However, treatment M₄ i.e. the combination of micronutrient produced significantly highest yields and yield attributes as compared to the rest of the combinations.

Keywords: Age of seedling, fertilizer levels, micro-nutrient, proso millet

Introduction

Millet is a prominent group of agronomical crops thrive and perform well under rainfed conditions, suitability under adverse conditions is the chief characteristic of these crops. India is a largest producer of many kinds of millet, which are often referred to as coarse cereals. However, realizing the nutrient composition of these grains they are now considered as nutritive cereals (Nutritious grains). In India small millet is cultivated over an area of 9.03 lakh ha with a total production of 4.45 lakh tones during 2014-15. In Maharashtra, the area under millets is 9309 thousand hectare and production is 9809 thousand tones with productivity of 1054 kg ha⁻¹ during 2005-06, with the largest area under millets is in the Konkan region comprising Raigad, Palghar, Thane, Sindhudurg and Ratnagiri district and submountain in region of Sahyadri i.e. in Kolhapur, Nasik, Satara, Sangali and Pune districts. Proso millet also has some medicinal properties which is recorded in Asian countries. It is beneficial as anti-ageing, nervous system, preventing cardiac disease preventing pellagra and other niacin dependent conditions, useful for strengthening bones, help to lower cholesterol, decreases risk of cancer, a rich source of essential phosphorous, help prevent gall stones, useful for people with celiac disease.

Apart from these, it has many other benefits too. It is most beneficial for post-menopausal women suffering from signs of heart ailments, they combat high blood pressure, provide iron, vitamin B₆, zinc which are all essential for our day to day functioning. Proso millet is known for its high nutritional value. The seeds are a rich source of protein (12-13%) and have long storability under ambient conditions and hence, suitable as a famine reserve (Ramesh *et al.*, 1998) [8]. It is rich in lysine, an amino acid, which is inadequate in most of the cereals. In addition to protein, it also contains about 1.1 percent crude fat, 68.9 percent carbohydrates, 2-3 percent minerals, 2.2 percent crude fiber, 3.4 percent ash, calcium 14 mg, phosphorous 206 mg and iron 5 mg per 100 grams. Fertilizer and micronutrients play an important role in increasing the production and improving quality of cereals. Micronutrient deficiency is a widespread problem throughout the country in major crop growing areas. Micronutrient become more deficient due to only straight fertilizer application at a vast scale like Urea, Murate of Potash and Single Super Phosphate. Zinc is an essential micronutrient for the normal growth, development and health of plants. Currently large areas of agricultural land are now known to be zinc deficient causing severe reduction in crop productivity and nutritional value of the crop. (Chetna Sinha 2016) [12].

Material Methods

The present investigation entitled "Effect of age of seedlings and different macro and micro nutrients on growth, yield and quality of proso millet (*Panicum miliaceum* L.) grown during kharif season of Konkan condition", was conducted at Agronomy farm, College of Agriculture, Dapoli, Dist, Ratnagiri (M.S.) kharif during a season of 2017. The topography of the experimental plot was uniform and levelled. The soil of experimental site was well drained. The composite soil sample from 0 to 30 cm layer was taken with the help of a screw auger before starting of a field experiment. Agronomy farm, college of Agriculture, Dapoli, Dist. Ratnagiri is situated in a tropical region at 17° 4' North latitude and 73° 1' East longitude having an elevation of 250 meters above mean sea level. The climate is tropical warm and humid which is very much favorable for crops like millet during Kharif season. the average annual precipitation of Dapoli is 3026.0 mm distributed from the beginning of June to October. The experiment was laid out in split split plot design with three main plot, two sub plot and four sub plot treatments. The main plot treatments composed of three different ages of seedlings of 20, 30 and 40 days old i.e. A₁, A₂ and A₃ respectively. The two sub plot treatments consisted different types of nutrient combinations viz., 100% RDF and 125% RDF i.e. N₁ and N₂ respectively and four sub plot treatments consist of Micronutrient viz. Control, Application of Zinc Sulphate @ 15 kg /ha, Application of Ferrous Sulphate @ 15 kg/ha and Combination of Zinc Sulphate and Ferrous Sulphate i.e. M₁, M₂, M₃ and M₄ respectively thus, the gross plot size was 3.6 m X 3.2 m and net plot size was 3.2 m X 2.9m respectively. The transplanting of proso millet variety vari no-10 was carried out by thomba method at spacing 20 cm x 15 cm. The recommended dose of fertilizers (RDF) was 80:40:00 NPK kg/ha. The recommended cultural practices and plant protection measures were taken as per recommendation given during an experiment.

Result and Discussion

Effect of age of seedlings

It was evident from the statistical findings and data presented

in Table.1 that a severe effect of seedling age was observed on growth characters of proso millet throughout the experimentation period. Transplanting of 30-day-old age seedling showed increased the growth parameters of proso millet such as plant height, a number of functional leaves hill⁻¹, Number of tiller hill⁻¹ and dry matter accumulation hill⁻¹ over rest of the treatments i.e. when a crop was transplanted with an age of 20- and 40-day-old age seedling.

The cause of maximum dry matter production hill⁻¹ as proso millet was transplanted with 30-day-old age seedling may be traced because of the significant increase in morphological parameters such as plant height, a number of leaves square m⁻¹ and a number of tillers hill⁻¹. This effect was due to conducive climatic conditions available to proso millet crop throughout the growth period compared to other sowing dates. This effect of the age of seedling on developmental studies is due to timely transplanting at a proper age i.e. number of leaves or may be the optimum load of green leaves on the plant or seedling. This cause substantial positive jerk in respect of rest of the attributes is mainly due to the stage at which crop transplanted is more ideal for their early survival after transplanting as they able to maintain transpiration pool, their energy requirement and i.e. most appropriate stage where a crop is able to manufactured food material for their own morphological development. Less is the stress on the seedling better will withstand capacity of the seedling. This cumulative effect augments resource utilization capacity i.e. light utilization and their conversion in to photosynthates, corroborative findings were reported by Bhatkar (1980) [1], Ghadge (1982) [4].

Grain yield per unit area in proso millet observed during experimentation was a function of yield attributing characters of an individual plant viz., a number of panicles hill⁻¹, length of panicle (cm), weight of panicle (g) and this cumulatively influencing eventually the grain yield obtained from the crop. The findings of the experiment revealed that when 30-day-old age seedling influencing positively and grew significantly maximum grain yield ha⁻¹ over rest of the age old seedlings i.e. 20 and 40 days. This increase in the grain yield due to a considerable improvement in photosynthetic activity which observed when proso millet transplanted at 30 days old seedling, this could be attributed to the substantially higher yield contributing characters a number of panicles hill⁻¹, length of panicle (cm) and weight of panicle (g). The significant increase in grain yield recorded under the sowing of proso millet when transplanted at seedling age of 30 days old over rest of age of seedlings. These results are in line with the finding of Kakad (2017) [5]. Transplanting of proso millet at seedling age of 30 days old recorded significantly higher grain yield and straw yield (Table. 2) over 20 and 40 age old seedlings. Stage of transplanting found to be more appropriate envisage that there was maximum food material production capacity was increased because of most balanced stage of root and shoot i.e. leaves which contributing more photosynthates and ultimately enhances and attain significantly more plant height, a number of leaves hill⁻¹, dry matter accumulation hill⁻¹ and number of tillers hill⁻¹. Photosynthates produced during an experimental period by the green leaves that is considered the site of action where it manufactured, during initial growth period it was used by the plant for their body building process and development that leads to substantial increased number of leaves, height and tillers and thereafter the potential physiological growth attain by the crop plant, During experimentation food material produced is utilized by crop

plant by diverting all food material, i.e. photosynthates towards expansion of reproductive structures of crop plant that is a flower, grain, their length etc. i.e. further maximum will be the source and ultimately more food material produced which was diverted towards the sink i.e. yield attributing characters and reflect on yield observed treatment where 30 days old seedling used for transplanting. These findings are in conformity with results got by Ghadage (1982) ^[4], Sarker *et al.* (2012) ^[9].

Effect of fertilizer levels

It was clear from the data presented in preceding unit that a noticeable outcome of different fertilizer levels was observed in respect growth character of proso millet throughout the crop growth period. Crop fertilized with more than their recommended fertilizer dose influencing numerically and statistically significant levels with increased the growth and development parameters of proso millet such as plant height, a number of functional leaves hill⁻¹, a number of tillers hill⁻¹, and dry matter accumulation hill⁻¹ as compared to crop fertilized with recommended fertilizer level. However, which was did not differ significantly with respectively in most of the morphological growth and development physiognomies. The augmented growth aspects may be accredited to the circumstance that individual plant access to the advantages of more and plentiful nutrients nearby the rhizosphere. This resulted in greater productivity of each plant hill as evident from the data with respect dry matter accumulation hill⁻¹. Singh (1999) ^[11] and Kakad (2017) ^[5] also reported similar findings.

Morphological and phenological development of an individual plant is the result of extent of availability of resource to that plant from soil and atmosphere. In this investigation, efforts was taken to understand whether any significant change in the rate of nutrient utilization of proso millet, during investigation it reveals that the response of crop to the increasing nutrient status nearby rhizosphere. This ultimately influencing the growth and yield attributing characters of crop under study. This availability of an optimum above ground and soil space, avoid inter plant competition for nutrition material which is encouraging for improved exploitation of solar energy, i.e. interception of light, CO₂ utilization and space for root development may be increased because of a level of fertilizer. Due to this more source is produced i.e. height, dry matter, leaves, tillers, etc. Similar results are in conformity with Jadhav *et al.* (2011), Vandana *et al.* (2012) ^[12].

Yield attributes and yield

Yield of crop per unit area in proso millet is a function of growth and yield attributes of an individual of plant viz., a number of panicles hill⁻¹, length of panicle (cm), weight of panicle (g) and eventually the grain yield attained from the plant. The findings revealed that higher values of growth parameters found in respect of leaves, height, and dry matter indicated more morphological parameters were enhanced due to the source which favors the maximum photosynthates produced. This more photosynthates produced during an initial phase of crop boosted the more tillers and yield attributing characters i.e. Sink. Higher is the source which favors consequently in the sink and subsequent parameters that enhanced the overall yield levels of the proso millet.

Among the various limiting factors of the crop growth and

development, nutrient is most important and limiting factor which play a crucial role in crop life cycle and their performance in relation to yield. Biological and enzymatic activities primarily controlled by the nutrient and their availability i.e. their optimum quantum, which regulate photosynthetic capacities and role in a specific body part development due to availability of Nitrogen, phosphorus and potassium at an optimum level enhanced the complementary effect. More is the yield attributing characters affecting significantly maximum yield levels per unit area. These findings are in conformity with Chouhan *et al.* (2015) ^[3], Pradhan *et al.* (2015) ^[7].

Effect micronutrient

It is clearly exhibited from statistical findings and data presented in table.1 that a severe outcome of seedling age was observed on growth characters of proso millet throughout the crop growth period. When a crop was fertilized with the micronutrient combination of ferrous and zinc sulphate showed increase growth parameters of proso millet such as plant height, a number of functional leaves hill⁻¹, and dry matter accumulation hill⁻¹ over rest of the treatments i.e. when crop fertilized with only ferrous sulphate and zinc sulphate separately and in control.

Results of the finding were due to various micronutrient combination on the growth and developmental parameter, which is resulted due to that, each nutrient play a crucial and specific role in the plant nutrition system and that exhibited on the enzymatic activities of the crop plant. Due to a favoring of the enzymatic activities encourages the plant growth particularly photosynthesis capacity and the ultimately food material production capacity. During experimentation crop is nurture either one or in a combination of zinc and ferrous sulfate. Crop performed at their potential level when it nourishes properly with supplementation of required nutrients. Present investigation an attempt was made to nourish crop with two micronutrients in combination. This better nourishment favors photosynthetic capacity and food material production of the crop, resulted in to a better source i.e. number of leaves hill⁻¹, dry matter production hill⁻¹, height (cm) etc. similar results were reported by Patel *et al.* (2013) ^[6], Sharma and Kumar (2009) ^[10].

Yield attributes and yield

Grain and straw yield per unit area in respect of proso millet observed during research, is a function of yield attributing characters of an individual plant viz., a number of panicles hill⁻¹, length of panicle (cm), weight of panicle (g) and this cumulatively influencing eventually the grain yield obtained from the plant.

This increase in the grain and straw yield is due to the effect of micronutrient application at a very minute level. The role of micronutrient is specific and its role cannot play by another and deficiency cannot be rectified by application of other nutrient therefore the micronutrient application that this effect applied first on the rhizospheric condition of the crop plant which is treated as active feeding zone of crop which influencing on the root growth, their expansion and this is due to better availability of an essential nutrient at very reasonable quantity and very easier and conveniently. This overall influencing the nutrient uptake pattern of crop their enzymatic activity, biochemical reactions synthesis more is the photosynthates and higher is the source available among the crop. Similar finding also reported by Wanjari *et al.* (2003).

Table 1: Mean plant population, plant height (cm), number of functional leaves hill⁻¹, number of tiller hill⁻¹, dry matter accumulation hill⁻¹ at harvest.

Treatments	Plant population net plot ⁻¹	Plant height (cm)	Number of leaves hill ⁻¹	Number of Tiller hill ⁻¹	Dry matter hill ⁻¹
Age of seedlings					
A1: 20 days old seedlings	297.21	159.76	8.05	3.37	32.32
A2: 30 days old seedlings	298.38	162.17	9.08	3.59	34.24
A3: 40 days old seedlings	295.88	155.41	7.20	3.26	30.98
F test	NS	Sig	Sig	Sig	Sig
S.Em+	0.57	1.118	0.053	0.031	0.244
C. D. at 5%	-	4.391	0.210	0.122	0.959
A) Fertilizer levels					
N1: 100% RDF	297.08	159.22	8.40	3.42	32.47
N2:125% RDF	297.22	159.00	7.82	3.45	32.56
F test	NS	NS	NS	NS	NS
S.Em+	0.18	0.158	0.057	0.036	0.131
C. D. at 5%	-	0.546	0.198	0.125	0.454
B)Effect of Micronutrients					
M1: control	297.06	157.93	6.17	3.24	31.74
M2: Zinc Sulphate @ 15 kg/ha	297.06	159.42	9.14	3.48	32.83
M3: Ferrous sulphate @ 15 kg/ha	297.11	158.35	7.70	3.40	32.34
M4: Combination of ZnSO ₄ and FeSO ₄	297.39	160.75	9.42	3.55	33.15
F test	NS	Sig	Sig	Sig	Sig
S.Em+	0.36	0.298	0.134	0.027	0.101
C. D. at 5%	-	0.854	0.383	0.079	0.289
C)Interaction effect					
F test	NS	NS	NS	NS	NS
S.Em+	0.890	0.729	0.327	0.067	0.241
General mean	297.15	159.11	8.10	3.34	32.51

Table 2: Mean value of different yield contributing characters of proso millet as influenced by different treatment.

Treatment	No. of panicles hill ⁻¹	Length of panicles (cm)	Weight of panicles (g)	Test weight (g)
A) Age of seedlings				
A1: 20 days old seedlings	3.30	37.02	9.04	1.52
A2: 30 days old seedlings	3.52	39.12	10.14	1.58
A3: 40 days old seedlings	3.18	34.29	8.51	1.49
F test	Sig	Sig	Sig	NS
S.Em+	0.04	0.72	0.23	0.03
C. D. at 5%	0.16	2.8	0.91	0.12
B) Fertilizer levels				
N1: 100% RDF	3.34	36.90	9.22	1.54
N2:125% RDF	3.34	36.71	9.24	1.56
F test	NS	NS	NS	NS
S.Em+	0.02	0.124	0.13	0.05
C. D. at 5%	0.9	0.428	0.47	0.16
A) Effect of Micronutrients				
M1: control	3.18	35.17	8.74	1.44
M2: Zinc Sulphate @ 15 kg/ha	3.41	37.37	9.35	1.47
M3: Ferrous sulphate @ 15 kg/ha	3.29	36.44	9.03	1.45
M4: 100% combination of ZnSO ₄ and FeSO ₄	3.47	38.25	9.79	1.50
F test	Sig	Sig	Sig	NS
S.Em+	0.02	0.16	0.08	0.04
C. D. at 5%	0.05	0.47	0.23	0.15
Interaction effect				
F test	NS	NS	NS	NS
S.Em+	0.050	0.407	0.201	0.038
General mean	3.33	36.80	9.22	1.55

Table 3: Mean of grain, straw yield (q ha⁻¹) and harvest index of proso millet as influenced by different treatments.

Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest Index
A) Age of seedlings			
A1: 20 days old seedlings	11.50	23.57	32.91
A2: 30 days old seedlings	13.27	27.63	32.45
A3: 40 days old seedlings	10.34	21.56	32.80
F test	Sig	Sig	NS

S.Em+	0.287	0.580	0.506
C. D. at 5%	1.127	2.279	1.986
B) Fertilizer levels			
N1: 100% RDF	11.20	23.06	32.98
N2: 125% RDF	12.20	25.45	32.45
F test	NS	Sig	NS
S.Em+	0.386	0.657	1.185
C. D. at 5%	1.334	2.272	4.100
C) Effect of Micronutrients			
M1: control	10.54	20.97	32.80
M2: Zinc Sulphate @ 15 kg/ha	11.66	25.57	31.30
M3: Ferrous sulphate @ 15 kg/ha	11.24	22.99	32.71
M4: Combination of ZnSO ₄ and FeSO ₄	13.37	27.48	33.06
F test	Sig	Sig	NS
S.Em+	0.282	0.745	0.897
C. D. at 5%	0.809	2.138	2.574
Interaction			
F test	NS	NS	NS
S.Em+	0.691	1.826	2.198
General mean	11.70	24.25	32.71

Conclusion

On the basis of present investigation, it can be concluded that for obtaining better growth, grain yield and quality from Proso millet, the 30 days age old seedling be transplant with application of 100 per cent recommended dose of fertilizer (80:40:00) along with micronutrient combinations (Ferrous Sulphate @15 kg ha⁻¹ + Zinc Sulphate @15 kg ha⁻¹).

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