Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 2922-2925
Received: 28-03-2019
Accepted: 30-04-2019

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Response of pearl millet (*Pennisetum glaucum* L.) to levels and scheduling of nitrogen under Maharashtra condition

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Abstract
A field experiment entitled "Response of pearl millet (*Pennisetum glaucum* L.) to levels and scheduling of nitrogen under Maharashtra condition" was conducted on medium black soil at National Agriculture Research Project, Aurangabad under Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the summer season 2009. The experiment comprising nine treatment combinations was laid out in factorial randomized block design and replicated three times. The treatment consisted combinations of three levels of nitrogen viz. 60 kg N/ha (N1), 90 kg N/ha (N2), 120 kg N/ha (N3) and three scheduling of nitrogen viz. Half at basal + Half at tillering stage (25 DAS) (T1), Half at basal + Half at leaf boot stage (45 DAS) (T2) and one third at basal + one third at tillering + one third at leaf boot stage (T3). The recommended dose of phosphorus @ 40 kg/ha was applied uniformly to all the treatment as basal in form of single super phosphate. Nitrogen was applied as per treatment in form of urea. Highest growth, yield attributes and yield of summer pearl millet can be obtained by fertilizing the crop with 120 kg N/ha with scheduling of nitrogen as the treatment T3 one third at basal + one third at tillering + one third at leaf boot stage (T3).

Keywords: Growth, yield attributes, yield, nitrogen levels, nitrogen scheduling

Introduction
Pearl millet belongs to family gramineae (poaceae). It is the most drought tolerant crop among cereals and millets and water requirement is low. The nutritive value of pearl millet is fairly high and it is fairly rich in fat content as compared to other cereals In India, it is annually grown on 7.95 million ha area producing nearly 8.79 million tonnes of grains with productivity of 1,106 kg/ha. (Anon., 2014). The major production factor to boost up the yield of pearl millet is fertilizer management, which has contributed to the extent of 27 per cent. Nitrogen, phosphorus and potassium are major elements required to increase the crop production. Among these elements, nitrogen is one of the decisive as well as expensive inputs which govern the cereal crops production. It has the quickest and the pronounced effect on plant growth. Insufficient nitrogen may reduce yield drastically and deteriorates the quality of produce. Split application of N fertilizers commensurate with crop growth stage is an useful approach for increasing the efficiency of applied N in Pearl millet it is therefore necessary to judiciously manage the inflow of the nitrogen. Therefore, levels and scheduling of nitrogen are crucial.

Materials and methods
The present study was conducted on National Agriculture Research Project, Aurangabad under Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the summer season 2009. The site is situated in the Central Maharashtra Platue Zone of Maharashtra which is characterized by fairly warm summer. The present investigation carried out with pearl millet hybrid variety AIMP-92901.It takes about 85-90 days to mature. It has long thick compact conical ear heads and produces obovate dark grey bold grains. It is also resistant to downy mildew disease. The experiment comprising nine treatment combinations was laid out in factorial randomized block design and replicated three times. The treatment consisted combinations of three levels of nitrogen viz. 60 kg N/ha (N1), 90 kg N/ha (N2), 120 kg N/ha (N3) and three scheduling of nitrogen viz. Half at basal + Half at tillering stage (25 DAS) (T1), Half at basal + Half at leaf boot stage (45 DAS) (T2) and one third at basal + one third at tillering + one third at leaf boot stage (T3). The recommended dose of phosphorus @ 40 kg/ha was applied uniformly to all the treatment as basal in form of single super phosphate. Nitrogen was applied as per treatment in form of urea.

Result and Discussion

Effect of nitrogen levels

Significantly higher plant height was recorded treatment N3 (120 kg N/ha) *i.e.* 170.67 cm at harvest, but it remain at par with treatment N2 (90 kg N/ha) *i.e.* 165.00 cm at harvest. Thus there is an increase in plant height with nitrogen application throughout the crop growth span. The probable reason might be positive effect of nitrogen on growth character due to augment of cell division and cell expansion. The study was in close conformity as observed by Rajput (2008) [11], Ali (2010) [1], Meena *et al.* (2012) [7], Patel (2014) [8, 12] and Raval *et al*. (2014) [12]. Number of effective tillers/plant at harvest were also increased with an increase in nitrogen level (Table 1) wherein an application of nitrogen @ 120 kg N/ha produced significantly higher (4.49) number of effective tillers/plant just before harvest as compared with 90 kg N/ha (N2) *i.e.* 3.29 and 60 kg N/ha (N1) *i.e.* 1.81. Nitrogen enhances the development of strong cell walls and therefore stiffer straw which might be resulted into profuse tillering. These results are already in agreement with those reported by Rajput (2008) [11], Ayub *et al*. (2007), Pathan and Bhilare (2009) [10] and Patel (2014) [8, 12]. The yield attributing characters *viz.,* ear head length, ear head girth and test weight were significantly influenced due to varying levels of nitrogen. Significantly higher ear head length (26.07 cm), ear head girth (9.21 cm) and test weight (8.83 g) were obtained under application of nitrogen in treatment N3 (120 kg N/ha) and found significantly superior over N2 and N1. While treatment N1 (60 kg N/ha) recorded lowest values of ear head length *i.e.* 22.30 cm, ear head girth *i.e.* 8.41 cm and test weight *i.e.* 7.49 g (Table 1). The probable reason for increase in test weight due to highest level of nitrogen might be attributed to the better filling of grains resulting into bold sized seeds and consequently highest test weight. Thus, all the yield attributes were remarkably improved and gave significant response of nitrogen application. The beneficial effect of nitrogen in growth and yield attributes were also reported by Patel and Patel (2002) [9], Sakarvadia *et al.* (2012) [13] and Patel (2014) [8, 12].

Grain yield of pearl millet (Table 2) was significantly influenced due to varying levels of nitrogen wherein significantly higher grain yield of 3910 kg/ha was achieved under treatment N3 (120 kg N/ha) and found significantly superior over N2 and N1. Whereas treatment N1 (60 kg N/ha) recorded significantly lowest grain yield (2984 kg/ha).

Fodder yield of pearl millet (Table 2) was significantly influenced due to varying levels of nitrogen wherein significantly higher straw yield of 6163 kg/ha was achieved under treatment N3 (120 kg N/ha) and found significantly superior over N2 and N1, whereas treatment N1 (60 kg N/ha) recorded significantly lowest fodder yield (4106 kg/ha). The highest grain & fodder yield could be due to the cumulative effect of improvement in yield attributes *viz*., number of effective tillers/plant, ear head length and girth and test weight. The improvement in straw yield was mainly on account of increase in the growth parameters due to nitrogen application. These results are also in agreement with findings of Hegde *et al*. (2006) [4], Ayub *et al*. (2009) [2], Jadhav *et al.* (2011) [5], Sakarvadia (2012) [13] and Patel (2014) [8, 12].

Effect of nitrogen scheduling

Data presented in Table 1 indicated that plant height recorded at harvest produced significantly by nitrogen scheduling. Plant height at harvest was significantly higher in nitrogen split application in treatment T3 (One third as basal one third at tillering and one third at boot stage) and remained at par with treatment T2 (Half as basal and half at leaf boot stage) and significantly superior over T1 (Half as basal and half at tillering). The improvement of growth and yield parameters with scheduling of nitrogen might have been attributed to better and timely availability of nitrogen for their utilization by plant. Similar result was reported by Mathukia *et al* (2014) [6] and Ali (2010) [1].

The yield attributing characters (Table 1) *viz.,* number of effective tillers/plant, ear head length, ear head girth and test weight were significantly influenced due to scheduling of nitrogen. Significantly higher value of ear head length (25.30 cm) and ear head girth (9.13 cm) were obtained under nitrogen application in treatment T3 (One third as basal one third at tillering and one third at boot stage) and remained at par with treatment T2 (Half as basal and half at leaf boot stage) *i.e.* ear head length 24.11 cm, ear head girth 8.89 cm and significantly superior over T1 (Half as basal and half at tillering).

In case of effective tillers/plant (3.66) and test weight (8.47 g) maximum values were obtained under nitrogen application in treatment T3 (One third as basal one third at tillering and one third at boot stage) and found significantly superior over T2 and T1. While treatment T1 (Half as basal and half at tillering) recorded lowest values of ear head length *i.e.* 23.26 cm, ear head girth *i.e.* 8.38 cm and test weight *i.e.* 7.92 g.

Grain yield of pearl millet (Table 2) was significantly influenced due to scheduling of nitrogen wherein significantly higher grain yield of 5022 kg/ha was achieved under treatment T3 (One third as basal one third at tillering and one third at boot stage) but it was at par with treatment T2 (Half as basal and half at leaf boot stage) *i.e.* 3566 kg/ha, whereas treatment T1 (Half as basal and half at tillering) recorded significantly lowest grain yield (3271 kg/ha). Similar results were recorded in case of fodder yield. Scheduling of nitrogen at different days after sowing produced remarkable increasing in growth and yield attributes and ultimately increasing of grain and straw yield. This may be due to reduced loss of nitrogen and extent supply, owing to continuous and sufficient availability of nitrogen during different growth and development period of the plant. Similar results were also reported by Choudhary and Prabhu (2014) [3], Tadesse *et al.*, (2013) [15], Mathukia *et al.*, (2014) [6] and Singh *et al.*, (2013) [14].

Interaction effect

The interaction effect of Nitrogen levels & time of application was found significant. The data is presented in Table 3. Nitrogen application at the rate of 120 kg N/ha to pearl millet in three split i.e. one third as basal one third at tillering and one third at leaf boot stage recorded maximum grain yield (4001 kg /ha).

Table 1: Growth and yield attributes of pearl millet as influenced by levels and scheduling of nitrogen

Treatment	Plant height at harvest	No of effective tillers/plant	Ear head length (cm)	Ear head girth (cm)	Test weight (g)
Nitrogen levels					
N_1- 60 kg N/ha	150.11	1.81	22.30	8.41	7.49
N_2 – 90 kg N/ha	165.00	3.29	24.29	8.78	8.21
N_3 – 120 kg N/ha	170.67	4.49	26.07	9.21	8.83
S.E.+	2.26	0.08	0.45	0.08	0.08
C.D. at 5%	6.82	0.25	1.36	0.26	0.23
Time of application					
T_1 – Half as basal and half at tillering	156.66	3.07	23.26	8.38	7.92
T_2 – Half as basal and half at leaf boot stage	161.44	2.87	24.11	8.89	8.15
T_3- One third as basal one third at tillering and one third at boot stage	167.67	3.66	25.30	9.13	8.47
S.E.+	2.26	0.08	0.45	0.08	0.08
C.D. at 5%	6.82	0.25	1.36	0.26	0.23
Interaction (N x T)					
S.E.+	3.91	0.14	0.78	0.14	0.13
C.D. at 5%	NS	0.43	NS	NS	NS

Table 2: Grain and fodder yield (kg/ha) of pearl millet as influenced by nitrogen levels and time of application

Treatment	Grain yield kg/ha	Fodder yield kg/ha
Nitrogen levels		
N_1- 60 kg N/ha	2984	4106
N_2 – 90 kg N/ha	3605	5107
N_3 – 120 kg N/ha	3910	6163
S.E.+	93.43	152.36
C.D. at 5%	279.46	456.23
Time of application		
T_1 – Half as basal and half at tillering	3271	4760
T_2 – Half as basal and half at leaf boot stage	3566	5097
T_3- One third as basal one third at tillering and one third at boot stage	3662	5518
S.E.+	93.43	152.36
C.D. at 5%	279.46	456.23
Interaction (N x T)		
S.E.+	161.62	264.00
C.D. at 5%	484.85	790.40
C.V.%	8.02	8.90
General mean	3499	5134

Table 3: Interaction effect of nitrogen levels and time of application on grain yield (kg/ha) of pearl millet

Grain yield (kg/ha)			
Nitrogen level	**Time of application**		
	T_1	T_2	T_3
N_1- 60 kg N/ha	2666	3353	3793
N_2- 90 kg N/ha	3072	3690	3937
N_3- 120 kg N/ha	3213	3771	4001
SE+	161.62		
CD at 5%	484.85		
CV%	8.02		
General Mean	3499		

Conclusion

Based on one year field experimentation, it is concluded that highest growth and yield attributes and yield of summer pearl millet can be obtained by fertilizing the crop with 120 kg N/ha with One third as basal one third at tillering and one third at boot stage along with recommended fertilizer dose of 40 kg P2O5/ha in Maharashtra.

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