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

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Abstract
A field experiment entitled "Response of pearl millet (*Pennisetum glaucum* L.) to levels and scheduling of nitrogen under south Gujarat condition" was conducted on heavy black soil at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the summer season 2016. The experiment comprising twelve treatment combinations were laid out in factorial randomized block design and replicated three times. The treatment consisted combinations of four levels of nitrogen viz. 60 kg N/ha (N_1), 80 kg N/ha (N_2), 100 kg N/ha (N_3) and 120 kg N/ha (N_4) and three scheduling of nitrogen viz. 50% at basal + 50 top dressing at 30 DAS (M_1), 50% at basal + 50% top dressing at 45 DAS (M_2) and 50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS (M_3). 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 80 kg N/ha 50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS.

Keywords: Growth, Yield attributes, Yield, Nitrogen levels, Nitrogen scheduling

1. 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) [2]. 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.

2. Materials and methods
The present study was conducted on the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer season of 2016. Navsari falls under Agro-ecological situation-III of south Gujarat Heavy Rainfall Zone which is characterized by fairly warm summer. The present investigation carried out with pearl millet hybrid variety GHB 558. It takes about 75-80 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 twelve treatment combinations were laid out in factorial randomized block design and replicated three times. The treatment consisted combinations of four levels of nitrogen *viz.* 60 kg N/ha (N_1), 80 kg N/ha (N_2), 100 kg N/ha (N_3) and 120 kg N/ha (N_4) and three scheduling of nitrogen *viz.* 50% at basal + 50 top dressing at 30 DAS (M_1), 50% at basal + 50% top dressing at 45 DAS (M_2) and 50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS (M_3). 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.

3. Result and Discussion

Effect of nitrogen levels

Significantly higher plant height was recorded treatment N_4 (120 kg N/ha) *i.e.* 76.25 cm at 45 DAS and 146.60 cm at harvest, but it remain at par with treatment N_3 (100 kg N/ha) *i.e.* 70.72 cm at 45 DAS and 144.40 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) [12], Ali (2010) [1], Meena *et al.* (2012) [8], Patel (2014) [9] and Raval *et al*. (2014) [13]. 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 (3.06) number of effective tillers/plant just before harvest as compared with 60 kg N/ha (N_1) *i.e.* 2.67 and 80 kg N/ha (N_2) *i.e.* 2.75 but statistically it was at par with 100 kg N/ha (N_3) *i.e.* 2.83. 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) [12], Ayub *et al*. (2007), Pathan and Bhilare (2009) [11] and Patel (2014) [9].

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 (25.89 cm), ear head girth (10.28 cm) and test weight (9.72 g) were obtained under application of nitrogen in treatment N_4 (120 kg N/ha) and remain at par with application of nitrogen in treatment N_3 (100 kg N/ha) *i.e.* number of effective tillers/plant 2.83, ear head length 24.94 cm, ear head girth 9.95 cm, test weight 9.36 g. While treatment N_1 (60 kg N/ha) recorded lowest values of number of effective tillers/plant *i.e.* 2.67, ear head length *i.e.* 22.83 cm, ear head girth *i.e.* 9.47 cm and test weight *i.e.* 8.67 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) [10], Sakarvadia *et al.* (2012) [14] and Patel (2014) [9].

Grain yield of pearl millet (Table 2) was significantly influenced due to varying levels of nitrogen wherein significantly higher grain yield of 4505 kg/ha was achieved under treatment N_4 (120 kg N/ha) but it was at par with treatment N_3 (100 kg N/ha) *i.e.* 4211 kg/ha and treatment N_2 (80 kg N/ha) *i.e.* 4055 kg/ha, whereas treatment N_1 (60 kg N/ha) recorded significantly lowest grain yield (3770 kg/ha). Straw yield of pearl millet (Table 2) was significantly influenced due to varying levels of nitrogen wherein significantly higher straw yield of 8856 kg/ha was achieved under treatment N_4 (120 kg N/ha) but it was at par with treatment N_3 (100 kg N/ha) *i.e.* 8322 kg/ha and treatment N_2 (80 kg N/ha) *i.e.* 8084 kg/ha, whereas treatment N_1 (60 kg N/ha) recorded significantly lowest grain yield (7356 kg/ha). The highest grain & straw 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) [5], Ayub *et al*. (2009) [3], Jadhav *et al.* (2011) [6], Sakarvadia (2012) [14] and Patel (2014) [9]. Nitrogen levels did not influence significantly on harvest index of pearl millet (Table 2). But numerically maximum harvest index of pearl millet (34.00%) observed under treatment N_1 (60 kg N/ha) and followed by treatment N_4 (120 kg N/ha) *i.e.* 33.73% and treatment N_3 (100 kg N/ha) *i.e.* 33.56%, while lowest harvest index produced under treatment N_2 (80 kg N/ha) *i.e.* 33.53%.

Effect of nitrogen scheduling

Data presented in Table 1 indicated that plant height recorded at 45 DAS and at harvest produced significantly by nitrogen scheduling. Plant height at 45 DAS was significantly higher in nitrogen split application in treatment M_1 (50% at basal + 50% top dressing at 30 DAS) and remained at par with treatment M_3 (50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS). While, plant height at harvest was significantly higher in nitrogen application in treatment M_3 (50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS) and remained at par with treatment M_2 (50% at basal + 50% top dressing at 45 DAS). 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) [7] 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 number of effective tillers/plant (2.96), ear head length (25.57 cm), ear head girth (10.13 cm) and test weight (9.57 g) were obtained under nitrogen application in treatment M_3 (50% basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS) and remain at par with application of nitrogen in treatment M_2 (50% basal + 50% top dressing at 45 DAS) *i.e.* number of effective tillers/plant 2.85, ear head length 24.26 cm, ear head girth 9.84 cm, test weight 9.23 g. While treatment M_1 (50% basal + 50% top dressing at 30 DAS)recorded lowest values of number of effective tillers/plant *i.e.* 2.67, ear head length *i.e.* 23.40 cm, ear head girth *i.e.* 9.62 cm and test weight *i.e.* 8.89 g.

Grain yield of pearl millet (Table 2) was significantly influenced due to scheduling of nitrogen wherein significantly higher grain yield of 4319 kg/ha was achieved under treatment M_3 (50% basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS) but it was at par with treatment M_2 (50% basal + 50% top dressing at 45 DAS) *i.e.* 4262 kg/ha, whereas treatment M_1 (50% basal + 50% top dressing at 30 DAS) recorded significantly lowest grain yield (3823 kg/ha). Straw yield of pearl millet was significantly influenced due to scheduling of nitrogen wherein significantly higher straw yield of 8661 kg/ha was achieved under treatment M_3 (50% basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS) but it was at par with treatment M_2 (50% basal + 50% top dressing at 45 DAS) *i.e.* 8157 kg/ha, whereas treatment M_1 (50% basal + 50% top dressing at 30 DAS) recorded significantly lowest straw yield (7646 kg/ha).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) [4], Tadesse *et al.*,(2013) [16], Mathukia *et al.,* (2014) [7] and Singh *et al.,* (2013) [15]. Scheduling of nitrogen did not influence significantly on harvest index of pearl millet. But numerically maximum harvest index of pearl millet (34.34%) observed under application of nitrogen in treatment M_2 (50% at basal + 50% top dressing at 45 DAS) and followed by treatment M_1 (50% at basal + 50% top dressing at 30 DAS) *i.e.* 33.47%, while minimum harvest index observed under nitrogen application in treatment M_3 (50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS) *i.e.* 33.31%.

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

Treatments	Plant height at 45 DAS (cm)	Plant height at harvest (cm)	Number of effective tillers/plant	Ear head length (cm)	Ear head girth (cm)	Test weight (g)
Nitrogen levels						
N_1	65.06	127.80	2.67	22.83	9.47	8.67
N_2	68.13	132.90	2.75	23.98	9.75	9.18
N_3	70.72	144.40	2.83	24.94	9.95	9.36
N_4	76.25	146.60	3.06	25.89	10.28	9.72
S.Em. ±	2.33	4.28	0.09	0.62	0.14	0.21
C.D. at 5%	6.84	12.55	0.25	1.82	0.42	0.61
Nitrogen scheduling						
M_1	73.38	131.00	2.67	23.40	9.62	8.89
M_2	65.46	137.10	2.85	24.26	9.84	9.23
M_3	71.28	145.56	2.96	25.57	10.13	9.57
S.Em. ±	2.02	3.70	0.07	0.54	0.13	0.18
C.D. at 5%	5.93	10.87	0.22	1.58	0.37	0.52
Interaction						
S.Em. ±	4.04	7.41	0.15	1.07	0.25	0.35
C.D. at 5%	NS	NS	NS	NS	NS	NS
C.V.%	10.00	9.31	9.18	7.66	4.42	6.71

N_1-60 kg/ha, N_2-80 kg/ha, N_3-100 kg/ha, N_4-120 kg/ha, M_1-50% at basal + 50% top dressing at 30 DAS, M_2-50% at basal + 50% top dressing at45 DAS, M_3-25% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS

Table 2: Grain yield, straw yield and harvest index of pearl millet as influenced by levels and scheduling of nitrogen

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Nitrogen levels			
N_1	3770	7356	34.00
N_2	4055	8084	33.53
N_3	4211	8322	33.56
N_4	4505	8856	33.73
S.Em. ±	156.40	306.60	1.02
C.D. at 5%	458.60	899.30	NS
Nitrogen scheduling7946			
M_1	3823	7646	33.47
M_2	4262	8157	34.34
M_3	4319	8661	33.31
S.Em. ±	135.40	265.60	0.88
C.D. at 5%	397.10	778.90	NS
Interaction			
S.Em. ±	270.80	531.12	0.35
C.D. at 5%	NS	NS	NS
C.V.%	11.34	11.28	9.09

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 80 kg N/ha 50% at basal + 25% top dressing at 30 DAS + 25% top dressing at 45 DAS along with recommended fertilizer dose of 40 kg P_2O_5/ha in south Gujarat heavy rainfall Agro-ecological situation III (AES-III).

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