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EFFECT OF CROP GEOMETRY AND NITROGEN MANAGEMENT ON GROWTH AND YIELD OF BARNYARD MILLET (*ECHINOCHLOA FRUMENTACEA* L.)

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SUMMARY

The present study was carried out during *kharif* season 2022-2025 at Chaudhary Charan Singh Haryana Agricultural University, Hisar to evaluate the crop geometry and nitrogen levels on the productivity of barnyard millet. The experiment was laid out in split plot design taking three spacing levels *i.e.* 20 cm × 10 cm, 25 cm x 10 cm, 30 cm x 10 cm in main plots and five nitrogen doses *viz.* 0, 20, 30, 40 and 50 kg N/ha in sub- plots with three replications. Among spacing levels, 30 cm x 10 cm followed by 25 cm x 10 cm was recorded with highest grain yield (1657 kg/ha), biological yield (9950 kg/ha) and Harvest index (16.98%). The application of increased dose of N brought profound increase in yield significantly over control. Among nitrogen levels, higher grain yield was recorded with 50 kg N/ha. However, grain yield, biological yield and straw yield was comparable with 40 kg N/ha.

Key words: Barnyard millet, spacing levels, nitrogen doses, grain yield and harvest index

Barnyard millet is one of the oldest domesticated millets of the semi-arid tropics of Asia and Africa. Among about 35 species, two main species are widely cultivated *Echinochloa esculenta* known as Japanese barnyard millet and *Echinochloa frumentacea* known as Indian barnyard millet. Barnyard millet is grown for both human consumption and fodder. Barnyard millet is the fourth most produced millet globally and plays an important role in food security for many poor populations (IIMR, 2018). Globally, the estimated area and production of small millets were 1.964 million hectares and 2.195 million tonnes (Anonymous, 2023). Nutri/coarse cereals include three major millets sorghum, bajra and finger millet and six minor millets *viz*., foxtail millet, little millet, kodo millet, proso milet, barnyard millet and brown top millet. In India, the area, production and productivity of nutri/coarse millets were 25.75 million hectares, 63.92 million tonnes and 2482 kg/ha, respectively (Anonymous, 2024-25). In India, minor/ small millet group is represented by six species, namely, finger millet [*Eleusine coracana*], kodo millet (*Paspalum scrobiculatum L.*), foxtail millet [*Setaria italica* (L)], little millet (*Panicum sumatrense*), proso millet (*Panicum miliaceum* L.) and barnyard millet (*Echinochloa frumentacea*). The area, production and productivity of small millets in India were 0.428 million hectares, 0.367 million tonnes and 935 kg/ha, respectively (Anonymous, 2023-24). In India, barnyard millet is the second important small millet after finger millet. Major barnyard millet growing states in India is Uttarakhand, Tamil Nadu, Maharashtra, Madhya Pradesh, Karnataka and North Eastern states.

Millets occupy a relatively lower position among feed crops in Indian agriculture; however, they are crucial for food security at both regional and farm levels. Frequent fluctuations in temperature and erratic rainfall limit productivity and cause loss of diversity. Barnyard millet is an important source of fodder because its leaves are broad and the plant grows rapidly, producing a large volume of highly palatable fodder suitable for hay or silage making. Owing to its fast growth and early maturity, the crop can produce up to eight harvests per year. The straw is considered a superior fodder compared with rice and oat straw due to its higher protein and calcium content (Obara, 1936). Under Indian conditions, the average dry fodder yield of barnyard millet is about 6 t/ha (Anonymous ,2020). Barnyard millet contributes nearly 11.5% of the total fodder consumption in Uttarakhand, and the application of different fertilizer doses significantly increases fodder yield (Yadav and Yadav, 2013).

Lower crop productivity is mainly attributed to poor crop management practices, such as inadequate planting density and nutrient management, severe weed infestation and the incidence of diseases and insect pests. Crop geometry is an important factor for achieving higher production through more efficient utilization of soil moisture and nutrients (via root spread) and above-ground resources (through plant canopy), enabling the crop to intercept maximum solar radiation and thereby enhance photosynthate formation (Uphoff *et al.*, 2011).

Proper nutrient management is essential to realize the maximum yield potential of the crop and to achieve higher economic return. Nitrogen application in non-leguminous crops significantly increases grain yield and is required in relatively large quantities. Studies have shown that the yield of millets increased by 10-75% (up to 34.11%) with the application of 20-40 kg N ha{ ¹ as reported by Reza (2012). Maintaining an optimum plant population through suitable spacing and proper dose of nitrogen is crucial for maximizing yield (Anandha Krishnaveni and Avudaithai 2020). Therefore, there is a need to study the relationship between crop geometry, nitrogen requirements and yield.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2022-2025 at the Research Farm, Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University Hisar, which is situated at 29°10' N latitude, 75°36' E longitude and altitude of 215.2 meters above mean sea level. The experiment comprised three spacing levels viz. S_1: 20 x 10 cm S_2: 25 x 10 cm and S_3: 30 x 10 cm in main plots and four nitrogen regimes viz. 0 kg N/ha (Control), 20 kg N/ha, 30 kg N/ha, 40 kg N/ha and 50 kg N/ha allotted to sub plots. The experiment was laid out in split plot design with three replications. Sowing was done in July first fortnight with seed rate of 8 kg/ha. Before sowing, seeds were treated with Carbendazim @ 2 g/ha and Azotobacter @ 200 g/ha. Seeds were sown at a depth of 3-5 cm. Urea and Single Super Phosphate were used as source of N and P_2O_5, respectively. Full dose of phosphorus and half of nitrogen was applied as basal dose and remaining half after first weeding and hoeing as per treatments. All other agronomic practices followed standard recommendations (Chapke, 2020). The barnyard millet harvested at physiological maturity indicated by yellowing of panicles, hardening of grains and grain moisture content 20- 25 %. At harvest stage the yield attributes viz., number of effective tillers/$m^{2,}$ fingers /earhead (no.), length of the panicle and grain yield were recorded. The straw yield was obtained by subtracting the grain yield from the biological yield. Data collected on various parameters of crop were subjected to statistical analysis to draw valid conclusion.

RESULTS AND DISCUSSION

Growth and yield attributes

The perusal of data in Table 1 shows that spacing and nitrogen levels had a substantial impact on the plant height, effective tillers/m^2, panicle length, fingers/ear head, weight of grains/earhead and test weight. The plant height and number of effective tillers/m^2 of barnyard millet was not significantly influenced by crop geometry levels. Increase in the levels of nitrogen, significantly influenced the plant height and

TABLE 1
Effect of crop geometry and nitrogen levels on growth and yield attributes of barnyard millet

Treatments	Plant height at maturity (cm)	Effective tillers/m2 (No.)	Panicle length (cm)	Fingers/ earhead (No.)	Weight of grains/earhead (g)	Test weight (g)
Crop geometry (cm)						
S_1: 20x10	135	129	17.9	32.9	5.42	5.59
S_2: 25x10	141	134	18.7	35.0	7.10	5.71
S_3: 30x10	146	136	19.5	36.6	7.58	5.79
CD (p=0.05)	NS	NS	1.17	1.89	1.39	NS
Nitrogen doses (kg/ha)						
0	125	100	15.8	29.4	5.13	5.09
20	137	119	17.9	32.8	6.59	5.36
30	141	136	19.2	34.9	6.83	5.67
40	147	145	19.7	37.1	7.30	6.00
50	152	166	21.1	39.9	7.62	6.37
CD (p=0.05)	3.24	17.3	0.708	1.33	1.12	0.29

TABLE 2

Effect of crop geometry and nitrogen levels on seed yield, biological yield, straw yield and harvest index of barnyard millet

Treatments	Grain Yield (kg/ha) 2024	Biological yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
S_1: 20x10	1397	8455	7058	17.23
S_2: 25x10	1553	8942	7389	18.21
S_3: 30x10	1657	9950	8292	16.98
CD (p=0.05)	121	NS	NS	NS
Nitrogen doses (kg/ha)				
0	847	6606	5759	14.32
20	1414	8564	7150	17.51
30	1674	9834	8159	18.0
40	1820	9963	8142	18.79
50	1923	10612	8689	18.75
CD (p=0.05)	105	754	784	2.65

TABLE 3

Correlation between seed yield, biological yield and harvest index

	Harvest index	Seed yield	Biological yield
Harvest index	1		
Seed yield	0.867769	1	
Biological yield	0.725882	0.9656	1

effective tillers/m^2. Increased plant height (152 cm) and effective tillers/m^2 (166/m^2) was associated with application of 50 kg N/ha, which was significantly higher compared to other treatments. These results were aligned with the observations of Anandha Krishnaveni and Avudaithai (2020) and Vidya and Raundal (2017) who reported that higher levels of nutrient attributes better growth in barnyard millet.

The crop geometry of 30 cm x 10 cm numerically showed higher yield parameters such as panicle length (19.5 cm), no. of fingers/ear head (36.6) and weight of grains/earhead (7.58 g) and was comparable with spacing of 25 x 10 cm. The increase in all growth and yield parameters might be due to sufficient availability of sunlight, water and nutrition from soil under proper spacing. These findings were supported by the findings of Krishnaveni and Avudaithai (2020).

The application of increased dose of N brought profound increase in yield attributes significantly over control. Application of 50 kg N/ha recorded higher panicle length (21.1 cm), no. of fingers/earhead (39.9), weight of grains/ earhead (7.62 g) and test weight (6.37 g) significantly over other treatments. However, weight of grains/ earhead was comparable with the application of 40 kg, 30, and 20 kg N/ha. Nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue formation for proper growth. The growth at higher level of nitrogen application *i.e.* 50 kg N/ha were increased significantly. These findings were supported by Aravind *et al.* (2019).

Barnyard Seed yield, biological yield, straw yield and Harvest index

Data on seed yield, biological yield and harvest index showed that crop geometry had significant influence on seed yield. Barnyard millet grown at a spacing of 30 x 10 cm registered higher seed yield (1657 kg/ha) and was comparable with 25 x 10 cm but significantly higher than 20 x 10 cm. However, biological yield, straw yield and harvest index of barnyard millet were not influenced by crop geometry levels.

The effect of nitrogen doses on grain yield of barnyard millet are shown in Table 2. The barnyard millet yield increased significantly with increased dose of nitrogen. The minimum grain yield was found in control *i.e.* 0 kg N/ha (847 kg/ha) during 2022-2025 and increase in yield was significant up to 40 kg N/ha. Maximum seed yield (1923 kg/ha), biological yield (10612 kg/ha) and straw yield (8689 kg/ha) were observed in 50 kg N/ha and it was comparable with 40 kg N/ha during three years of experiment. These findings reveal that supply of increased doses of nitrogen upto 50 kg N/ha to barnyard millet adequately supports the crop growth as the yield is at par with the 40 kg N/ha. The significantly higher grain yield (127%), stover yield (51%) and biological yield (61%)

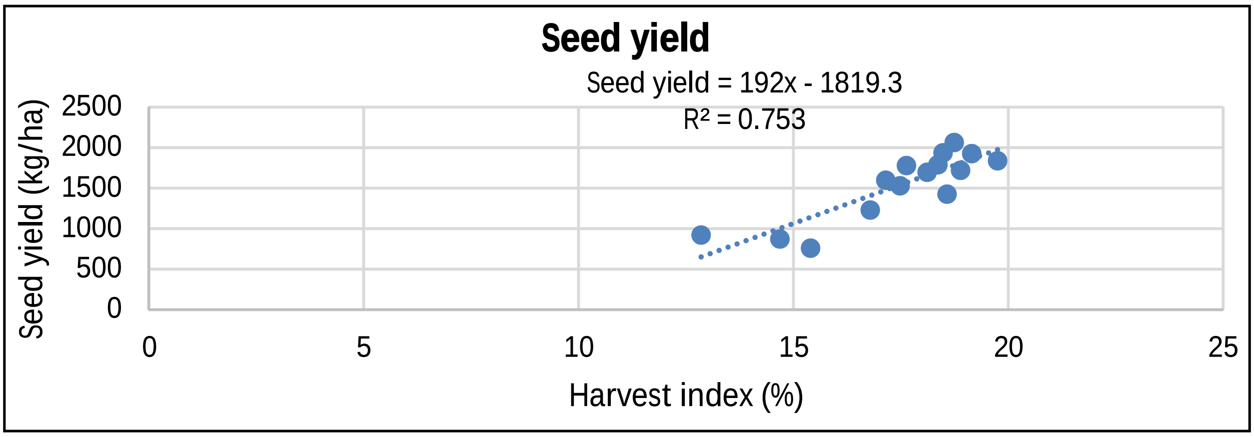
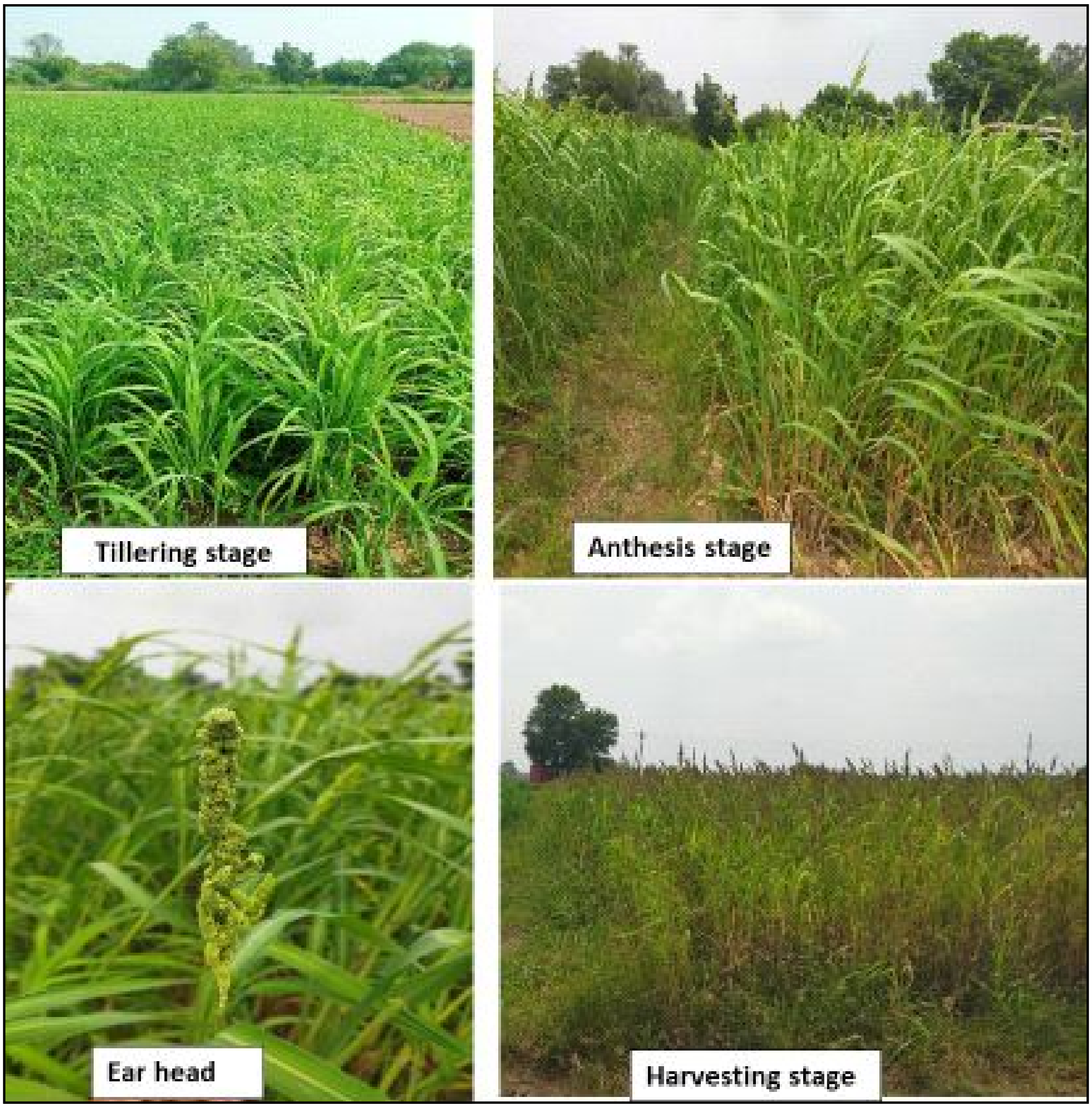


Fig. 1. Regression line showing the relationship of Harvest index with Seed yield



Glimpses of different stages of Barnyard millet

along with the harvest index (30 %) in 50 kg N/ha over control were because of more availability of nutrients for their growth and development of better yield attributes and yield. Similar findings were reported by (Nandini *et al*, 2018). The poor nutrition in control affected the grain yield more than biological yield which ultimately resulted in significant reduction in harvest index. Harvest index is the parameter which dependent on seed yield (r= 0.87) and biological yield (r=0.73) (Table 3). This shows that harvest index was more associated with seed yield than biological yield. Th e harvest index can also be computed from the seed yield with regression equation (SY= -1819.3+192HI, r^2=0.75, Fig, 1). This decline in response of nitrogen at higher doses may be explained with the well-established Mitscherlich equation.

CONCLUSION

Based on the three-year study, it can be concluded that barnyard millet sown at 25 cm x 10 cm and application of 40 kg N/ha was found most remunerative crop geometry and suitable nitrogen dose for having highest growth and seed yield under Hisar conditions.

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