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RESPONSE OF BAJRA HYBRID TO SPACINGS AND NITROGEN LEVELS IN RAINFED ALFISOLS

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ABSTRACT

A field experiment was conducted to study the response of bajra hybrid (ABH-1) to spacing and nitrogen levels in alfisols of scarce rainfall zone under rainfed conditions during *kharif,* 2015-16 at Agricultural Research Station, Ananthapuramu. The experiment was laid out in Factorial RBD and replicated thrice. The results revealed that bajra sown at 60 × 15 cm produced higher growth, yield attributes, yield and economics. Among different nitrogen levels, application of 80 kg N ha^{-1} resulted in tallest plants and 60 kg N ha^{-1} produced higher drymatter production. Application of 100 kg N ha^{-1} produced higher leaf area and leaf area index, yield attributes whereas grain yield was higher with application of 60 kg N ha^{-1} and straw yield was higher with application of 80 kg N ha^{-1}.

KEYWORDS: Bajra hybrid, Spacing, Nitrogen levels, Alfisols

INTRODUCTION

Bajra (Pearlmillet) the world's hardiest warm season cereal crop (Reddy *et al.,* 2013), is an indispensable arid and semi arid crop of India (Ramesh *et al.,* 2006) cultivated as dual purpose (food and feed) crop in over 8.3 m ha ranking fourth among total cereals. Further, the nutritional value of bajra offers much scope to development of value added products in new health conscious consumer segments (Yadav *et al.,* 2011) as it contains more fibre and is good for diabetic and heart patients. It is the richest sources of nutrition, especially iron, calcium and zinc among cereals and hence can provide all the nutrients at least cost compared to wheat and rice (Parthasarathy *et al.*, 2006).

Pearl millet is efficient in its utilization of moisture and has a higher level than jowar and maize. Water stress decreased water potential, transpiration efficiency, rate of stomatal conductance, photosynthesis efficiency of flag leaves. The application of balance nutrients and their better utilization under moisture condition for enhancing growth, yield and yield attributing parameters of crops is important factor under rainfed condition. Fertilization of crop enhance water use efficiency, controlling soil erosion by promoting rapid and vigorous growth of crop to check runoff and increases the water holding capacity of soil. Application of nitrogen helps in better vegetative growth of plants and improving the quality of grains.

Bajra is an exhaustive crop that requires more nitrogen. The productivity of the crop is very low (25-26 q ha^{-1}) due to imbalance application of fertilizers, adopting improper intrarow spacing, uncertain and erratic distribution of rainfall. Nitrogen is the major nutrient required by bajra and has shown variable growth and yield response to N application (Gascho *et al.,* 1995). Generally, bajra has been known for growing under low N management, several studies showed that N application can increase pearlmillet production efficiency (Singh *et. al.*, 2010). Nitrogen use efficiency (NUE) of bajra is higher than many other crops, increasing the rate of N fertilization does not always accompany a corresponding increase in grain yield (Muchow, 1988).

Ananthapuramu district is the second most drought - affected district of India. It receives around 500 mm rainfall annually. The agriculture is predominantly dependent on rainfall which is very erratic and uncertain. Being located in the scarce rainfall zone of Andhra Pradesh does not get the full benefit of either the southwest or northeast monsoon. In this region bajra is an important crop produces food and fodder within a short period of 85 to 90 days for resource poor farmers. Quantity of nitrogen requirement depends on the inherent fertility status of the soil, season and planting pattern besides several other factors. Agronomic variations among pearl

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millet genotypes have been reported earlier by Khairwal *et al*. (2007). So there is a need to improve yields of bajra hybrid by refining the existing agronomic practices. Pertinent information regarding optimum nitrogen dose and spacing for bajra hybrid during kharif season is meagre. Keeping this in view present experiment was conducted to study the response of bajra hybrid to spacing and nitrogen levels under rainfed condition.

MATERIAL AND METHODS

A field experiment was conducted to study the response of bajra hybrid to spacing and nitrogen levels in alfisols of scarce rainfall zone under rainfed conditions during *kharif,* 2015-16 at Agricultural Research Station, ANGRAU, Ananthapuramu of Andhra Pradesh. The soil of the experimental site was red sandy loam with shallow depth, low in organic carbon (0.34%) and low in available nitrogen (138 kg ha^{-1}), medium in available phosphorous (28 kg ha^{-1}) and potassium (215 kg ha^{-1}). The experiment consisted of three spacings (S_1: 30 ×15 cm, S_2: 45 × 15 cm and S_3: 60 × 15 cm) and five nitrogen level treatments *viz*., N_1: Control (No N), N_2: 40 kg ha^{-1}, N_3: 60 kg ha^{-1}, N_4: 80 kg ha^{-1} and N_5: 100 kg ha^{-1}. The experiment was laid out in Factorial RBD with three replications. The experimental field was prepared by working with a tractor drawn disc plough and then tractor drawn cultivator was drawn along the field. The individual plots were laid out according to the layout plan. Healthy seeds of bajra hybrid (ABH-1) with good germination percent (95%) were used for sowing purpose. ABH – 1 (Ananthapuramu Bajra Hybrid-1) is a pre released hybrid developed at Agricultural Research Station, ANGRAU, Ananthapuramu and ready for release in the state of Andhra Pradesh for farmers cultivation. The seeds were sown by dibbling method in furrows at a depth of 5 cm. As per the treatments half of the N, entire P_2O_5 and K_2O were applied at the time of sowing in the form of urea, single super phosphate and muriate of potash, respectively. Remaining half nitrogen was applied around 30 DAS depending on rainfall event. Thinning and gap filling was done for maintaining optimum plant density. Weeding and hoeing were taken up depending on the intensity of weeds at critical stages of crop weed competition. All other cultural practices kept normal and uniform for all treatments. At harvest, five plants were randomly selected from each treatment for recording growth and yield parameters. Leaf area was calculated at 30 and 60 DAS. The portable area meter with transparent belt conveyer utilizing an electronic digital display was used for measuring leaf area. Then the LAI was calculated by dividing the total leaf area with the corresponding land area as suggested by Watson (1952). LAI = Total leaf area/unit land area. The crop was harvested from a uniform net plot (5 × 5 m) in all treatments for recording grain and straw yields which were expressed in kg ha^{-1}. Labour charges and cost of inputs were worked out to compute the cost of cultivation. Gross returns were calculated based on local market price of bajra and net returns by subtracting the total cost of cultivation from gross returns.

RESULTS AND DISCUSSION

Rainfall and Crop Performance:

The details of sowing, harvesting, rainfall and rainy days are given in Table 1. It is observed that the rainfall during the year of experimental study is within the limits of normal and the crop has also received normal rainfall of 247.8 mm in 21 rainy days during its growth period of 83 days. The details of temperature and rainfall distribution (Table 2) reveal that the temperatures (maximum and minimum) were within the normal range during all the growth stages. The distribution of rainfall was optimum during different phenophases except during the period from panicle emergence to flowering. There was a well distribution of rainfall of 170.4 mm during the critical periods from flowering to maturity, which helped the crop to give better yields.

Response of bajra hybrid to spacing and nitrogen level

Growth

Plant height measured at harvest was not significantly influenced by the adopted spacing (Table 3). The crop spaced at 60 × 15 cm recorded maximum plant height at harvest. This result is contradictory to plant height significantly increased with wider row spacing as reported by Maas *et al*. (2007). At harvest, plant height was significantly influenced by nitrogen levels. Maximum plant height was recorded with 80 kg N ha^{-1} which was comparable with 100 and 40 kg N ha^{-1}. Interaction effect due to adopted spacing and applied level of nitrogen was found non significant.

Drymatter production did not differ significantly due to adopted spacing. The crop spaced at 60 × 15 cm produced larger amount of drymatter. Drymatter production was significantly influenced by nitrogen levels. Highest drymatter production was recorded with 60 kg N ha^{-1} which was comparable with 80 and 100 kg N ha^{-1}.

Table 1. Rainfall and rainy days during crop growth period

Date of sowing	16-07-2015
Date of harvesting	06-10-2015
Crop duration (days)	83
Normal annual rainfall (mm)	590.6
Actual annual rainfall (mm)	641
Rainfall during crop period (mm)	248.0
Number of rainy days during the year	44
Number of rainy days during crop period	21

Table 2. Weather recorded during different phenophases of bajra

Phenophases	Days Taken	Maximum Temperature (° C)	Minimum Temperature (°C)	Rainfall (mm)	Rainy days
Sowing to Emergence	7	33.9	25.2	10.6	1
Emergence to panicle emergence	42	35.1	24.6	67.0	8
Panicle emergence to flowering	51	34.7	24.8	0.0	0
Flowering to grain formation	61	33.7	24.2	116.0	6
grain formation to maturity	83	33.2	24.1	54.4	6

Nitrogen is the main component of the protoplasm involving in various metabolic processes *viz.* photosynthesis, stimulation of cell division and elongation (Ali, 2010). These leads to increase in dry matter accumulation (Ayub *et al.,* 2009). Interaction effect of spacing and nitrogen levels on drymatter production was found non significant.

Leaf area was significantly influenced by spacing at 30 and 60 DAS. Among different spacings, significantly highest leaf area was recorded with 60 × 15 cm compared to 30 × 15 cm and 45 × 15 cm which inturn comparable to each other at 30 DAS. At 60 DAS, 60 × 15 cm recorded significantly higher leaf area compared to 30 × 15 cm and 45 × 15 cm with significant disparity between both of them. Leaf area was significantly influenced by nitrogen levels at 30 and 60 DAS. Among different nitrogen levels, application of 100 kg N ha^{1} and 80 kg N ha^{1} recorded significantly highest leaf area compared to other treatments at 30 DAS and 60 DAS. The interaction effect was found significant at 30 DAS while at 60 DAS, it was found non significant.

Leaf area index was significantly influenced by spacing at 30 and 60 DAS. The crop spaced at 30 × 15 cm recorded significantly higher leaf area index compared to 45 × 15 cm and 60 × 15 cm with significant disparity at 30 DAS. The trend was changed at 60 DAS, the crop spaced at 30 × 15 cm recorded significantly highest leaf area index compared to the crop spaced at 45 × 15 cm and 60 × 15 cm. Leaf area index was significantly influenced by nitrogen levels at 30 and 60 DAS. Among different nitrogen levels, 100 kg N ha^{-1} and 80 kg N ha^{-1} found significantly superior to all other treatments which were comparable with each other. The interaction effect was found significant at 30 DAS while at 60 DAS, it was found non significant. Higher stature of growth attributes viz., leaf area and leaf area index were observed with the application of higher nitrogen levels. While all these parameters were at their lowest value with no nitrogen application. It could be attributed to the fact that higher nitrogen levels might have accelerated the synthesis of more chlorophyll and amino acids and stimulated the cellular activity, which is useful for the process of cell division, meristematic growth coupled with cell enlargement, resulting in production of larger leaves which ultimately leads to enhanced dry matter accumilation.

Yield attributes

The variable spacing has not exerted any significant influence on yield attributes of hybrid bajra (Table 4). However, highest panicles per m^2 were recorded with 60 x 15 cm and the lowest was recorded with 30 x 15 cm spacing. Maximum panicle weight and grain weight per panicle were recorded with 60 x 15 cm spacing and the lowest was recorded with 45 x 15 cm spacing.

Number of panicles per plant was higher with application of 100 kg N ha^{-1} which was comparable with 80, 60 and 40 kg N ha^{-1} and significantly superior over control which recorded lowest number of panicles per plant. These results were contradictory to Eric Obeng *et al*. (2012) who reported that nitrogen rates 0, 40, 80 and 120 kg N ha^{-1} did not show any significant difference for number of panicles.

Variation in panicle weight was significant due to different nitrogen levels. Maximum panicle weight was recorded with 100 kg N ha^{-1} which was comparable with 60 and 80 kg N ha^{-1} and significantly superior over 40 kg N ha^{-1} and control. Grain weight per panicle was significantly influenced by different nitrogen levels tested. Maximum grain weight per panicle was recorded with 100 kg N ha^{-1} which was significantly superior to all other treatments. The interaction effect was found significant due to adopted plant density and applied nitrogen level. The crop spaced at a wider row spacing of 60 cm recorded maximum grain weight per panicle with application of 100 kg N ha^{-1}. The improvement of panicle weight and grain weight per panicle with progressive increase of nitrogen levels was also reported by Ali (2010).

Grain, Straw yield and Harvest Index

Grain yield was not significantly influenced by variable spacing. However, 60 × 15 cm spacing recorded maximum grain yield compared to 45 × 15 cm and 30 × 15 cm. Similar results were reported from the studies of Shekhawat *et al*. (1972). They observed that bajra yields were not significantly affected by the adopted spacing. Variation in grain yield was remarkable due to applied level of nitrogen. Maximum grain yield was recorded with 60 kg N ha^{-1} compared to lower level of 40 kg N ha^{-1} and higher level of 80 kg N ha^{-1} and 100 kg N ha^{-1} with significant parity between treatments. The lowest grain yield was registered with control treatment. It was observed that grain yield increased with increase in nitrogen level from 0 to 60 kg ha^{-1} but further increase of N until 100 kg ha^{-1} did not result in further increase in grain yield. Similar results were reported by Hassan and Bibinu (2010), Jat *et al*. (1994) and Sharma *et al*. (1999) from their studies that grain yield of bajra was increased with increased levels of nitrogen. The interaction effect due to adopted spacing and applied levels of nitrogen on grain yield was found non significant.

Straw yield was significantly influenced by the adopted spacing. The crop spaced at spacing of 60 × 15 cm registered highest straw yield compared to 30 × 15 cm and 45 × 15 cm. Among different levels of nitrogen tried, highest straw yield was recorded with 80 kg N ha^{-1} compared to 40 and 100 kg N ha^{-1} with significant parity. The lowest straw yield was recorded with control. Among different levels of nitrogen, 80 kg ha^{-1} was optimum as it gave significantly higher grain and straw yield compared to 40, 60 kg N ha^{-1} and on par yield at 100 kg N ha^{-1}. The increased yield response up to a dose of 80 kg N ha^{-1} compared to a higher dose of 100 kg N ha^{-1} can be attributed to increased uptake of nitrogen. As the soil was deficient in available nitrogen, the crop absorbed this nutrient efficiently and thereby enhanced the dry matter production. This might have resulted in more number of panicles per m^2 that supported higher grain and straw yield (Yakadri M and Pratap Kumar Reddy, 2009). The interaction effect was found to be non significant with spacing and different levels of nitrogen.

Economics

Net returns and B:C ratio were not significantly influenced by spacings and nitrogen levels. However, highest net returns and B:C ratio was recorded with 60 × 15 cm and the lowest net returns and B:C ratio was recorded with 30 × 15 cm. Among nitrogen levels, higher net returns and B:C ratio was recorded with application of 40 kg N ha^{-1} compared to 60, 80 and 100 kg N ha^{-1} which inturn comparable to each other. Though application of 40 kg N ha^{-1} recorded lesser yield compared to 60, 80 and 100 kg N ha^{-1}, it is found economical due to higher net returns and B:C Ratio. The lowest net returns and B:C ratio was recorded with control. The interaction effect was found to be non significant with different levels of nitrogen and spacing.

Table 3. Growth of bajra hybrid as influenced by spacing and nitrogen levels in rainfed alfisols

Treatments	Plant height at harvest (cm)	Drymatter production at harvest (g plant^{-1})	Leaf area (cm^2)		LAI	
			30 DAS	60 DAS	30 DAS	60 DAS
Spacing						
S_1 : 30 × 15 cm	98.2	53.2	319	466	0.71	1.04
S_2 : 45 × 15 cm	97.9	56.7	323	532	0.48	0.79
S_3 : 60 × 15 cm	98.5	60.1	341	657	0.38	0.73
S.Em ±	2.89	2.41	43.9	76.5	0.015	0.04
CD at 5%	NS	NS	15.2	26.4	0.043	0.12
N levels (kg ha^{-1})						
N_1 : Control (No N)	90.3	53.9	278	403	0.46	0.62
N_2 : 40 kg ha^{-1}	101.5	53.4	324	499	0.53	0.78
N_3 : 60 kg ha^{-1}	94.8	60.2	297	564	0.49	0.87
N_4 : 80 kg ha^{-1}	102.8	59.3	362	603	0.57	0.93
N_5 : 100 kg ha^{-1}	101.7	57.4	378	690	0.61	1.06
S.Em ±	2.13	1.07	11.9	34.1	0.019	0.05
CD at 5%	6.1	3.1	35	99	0.06	0.15
Interaction (S × N)	NS	NS	59.7	NS	0.097	NS

Table 4. Yield attributes and yield of bajra hybrid as influenced by spacing and nitrogen levels in rainfed alfisols

Treatments	Number of panicles plant^{-1}	Panicle weight (g)	Grain weight panicle^{-1} (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net returns (₹ ha^{-1})	B: C ratio
Spacing							
S_1 : 30 x 15 cm	1.56	23.7	16.1	2720	3078	28573	2.34
S_2 : 45 x 15 cm	1.56	23.6	15.2	2828	3019	30203	2.46
S_3 : 60 x 15 cm	1.75	26.2	17.2	2988	3344	32595	2.67
S.Em ±	0.09	0.98	0.66	97.9	83.9	1468	0.12
CD at 5%	NS	NS	NS	NS	243	NS	NS
N levels (kg ha^{-1})							
N_1 : Control (No N)	1.42	23.1	15.5	2431	3034	24968	2.17
N_2 : 40 kg ha^{-1}	1.58	23.9	15.2	2790	3142	34233	2.85
N_3 : 60 kg ha^{-1}	1.62	24.8	16.1	3083	3048	29581	2.41
N_4 : 80 kg ha^{-1}	1.69	24.6	16.1	2964	3354	31924	2.54
N_5 : 100 kg ha^{-1}	1.87	26.3	18.2	2958	3157	31578	2.47
S.Em ±	0.12	0.78	0.63	126.4	91.2	1896	0.16
CD at 5%	0.35	2.3	1.8	366	268	5494	NS
Interaction (S × N)	NS	NS	4.26	NS	NS	NS	NS

From the above results, it can be concluded that bajra hybrid can be grown at inter row spacing of 45 or 60 cm to get higher grain yield and net returns under rainfed conditions. Though, application of 60 and 80 kg N ha^{-1} resulted in highest grain and straw yield, application of 40 kg N ha^{-1} is optimum because of higher net returns and B:C ratio.

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