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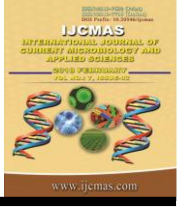

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Effect of Planting Geometry and Nutrient Levels on the Productivity of Buckwheat

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ABSTRACT

Keywords

Primary branches, LAI, Nodes per plant, Clusters per plant, Buckwheat

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A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka during *kharif* season of 2016-17 to study the effect of plant spacing and different levels of nutrients on the productivity of buckwheat. The experiment was laid out in split plot design with three replications**.** The treatments comprised of three plant spacing as main plot *viz.*, 30 X 10 cm, 30 X 15 cm and 30 X 20 cm and three nutrient levels as sub plot *viz.*, 35:20:20 NPK kg ha^{-1}, 35:15:15 NPK kg ha^{-1} and 25:10:10 NPK kg ha^{-1}. Among the plant spacing, significantly taller plant height (73.2 cm), LAI (2.3), clusters per plant (5.2), seeds per cluster (8.3), grain yield (6.2 q ha^{-1}) and straw yield (10.3 q ha^{-1}) was observed with spacing of 30 X 10 cm. Among the nutrient levels, application of 35:20:20 NPK kg ha^{-1} recorded significantly LAI (2.5), nodes plant $^{-1}$ (20.4), clusters per plant (5.0), seeds per cluster (8.5), test weight (26.6 g), grain yield (6.0 q ha^{-1}) and straw yield (10.2 q ha^{-1}).

Introduction

Buckwheat (*Fagopyrum species*) is an old traditional underutilized crop plant belonging to the family Polygonaceae that been used as staple food for local communities in India, Nepal, Bhutan and China predominantly in the hilly and temperate area of Europe and East Asia. It is curative herb or feed for animals long back until the expansion and industrialization of agriculture masked this crop and left behind all its significance, advantages and potential in the race towards the maximum amount producing crops. It grows well in all areas with low fertile soil, limited rainfall, used as a green manure and plant for erosion control thus, source of income for farmers. Buckwheat is eaten during fasting in India considering it to be a fruit not as a grain. Buckwheat grains are an important source of macro elements such as K, Ca, Mg, and Na as well as micro elements such as Mn, Zn, Se, and Cu (Wei *et al.*, 2003), and they contain rutin, riboflavin, pyridoxine, thiamine, lysine, methionine, arginine, and threonine (Fabjan *et al.*, 2003).

A crop would express its full potential only when it is backed up by good agronomic practices. Optimum plant density provides conditions for proper light interception throughout the crop growth period. Further, it is important to realize that plant density should be defined not only in terms of number of plants per unit area but also in terms of arrangement of these plants on the ground (planting geometry/spatial arrangement) as it helps in efficient harvesting of solar energy with least competition for growth factors *viz.,* water and nutrient uptake which ultimately decides the expression of phenotypic and genotypic character of the crop. All these factors influence the crop growth, seed yield and quality parameters.

Nutrients are important and crucial elements, which are required for the plant for its growth and development. The translocation of photosynthates from source to sink is very important for the development of economic part. One of plant's basic elements is nitrogen. Buckwheat response to nitrogen depends on primary nitrogen content of the soil, climatic conditions and nitrogen additives as well as its addition time.

Materials and Methods

To study on evaluation of plant density and nutrient levels on growth and yield of Buck wheat, the field experiment was carried out at Main Agricultural Research Station, Dharwad, Karnataka during the *kharif* season of 2016-17. The Station located between 15^0 30^1 6^{11} North latitude and at longitude of $74^0 59^1 12.4^{11}$ East at an attitude of 678 m above MSL. The Experiment was laid out in split plot design with three replications having three planting densities *viz.,* S_1 -30 x 10 cm, S_2 - 30 x 15 cm and S_3- 30 x 20 cm as main plots, three nutrient level *viz.,* F_1- 35:20:20 NPK kg ha^{-1}, F_2- 35:15:15 NPK kg ha^{-1} and F_3 - 25:10:10 NPK kg ha^{-1} as sub plots.

Plant height was measured by taking five plants randomly from individual plant and measured in centimetre from the ground level. Lead Area Index (LAI) was calculated by disc method as suggested by Vivekanandan *et al.,* (1972). The full amount of phosphorus and potash and a half of the nitrogen per treatment was applied at the time of sowing. The remaining half of the nitrogen was applied 30 days after sowing. Other crop management practices were carried out in accordance with local agronomic practices. Crop was harvested at physiological maturity stage. After harvesting, the plants were bundled and allowed for sun drying. The grains were separated from the dried plants by threshing and winnowing. Grains from individual plots were cleaned, dried and weight was recorded. The data collected from the experiment at different growth stages and at harvest was subjected to statistical analysis as described by Gomez and Gomez (1984).

Results and Discussion

Climatic conditions, soil type, location, sowing time and varieties will determine the optimum planting density. Among the planting geometry, taller plants were recorded at a spacing of 30 X 10 cm at harvest (73.2 cm) and it was on par with spacing of 30 X 15 cm (71.5 cm) compared to 30 X 20 cm (68.0 cm) (Table 1). This was due to less inter-plant competition for light. A possible reason for increased accumulation is that the more number of plants per unit area increased both the photosynthesizing area and the volume of roots per unit soil surface, allowing the crop to improve the exploitation of environmental resources. Lower light interception at wider row spacing could have reduced assimilate production (Amjad and Anderson, 2006).

Significantly higher leaf area index (2.3) was recorded when plants were grown with spacing of 30 X 10 cm and it was on par with spacing of 30 X 15 cm compared to spacing of 30 X 20 cm (1.7) (Table 1). A possible reason for increased LAI was due to optimum plant density and optimum row spacing improves the light interception which ultimately results in the increased interception of photo synthetically active radiation. At higher densities, canopy allows for more efficient light interception and penetration which consequently results in higher photosynthetic rates specifically at leaves located in the lower portion of the canopy. Significantly higher primary branches plant^{-1}, nodes plant^{-1} and petiole length was recorded in the spacing of 30 X 10 cm (5.6, 19.5 and 6.2, respectively) and it was on par with spacing of 30 X 15 cm (5.1, 18.0 and 6.0, respectively). This was due to optimum availability of all resources. Although primary branches, nodes and petiole length is a varietal character, but it is also influenced by temperature, humidity and better crop management.

The planting density of 30 X 10 cm produced significantly higher grain (6.2 q ha^{-1}) and straw yield (10.3 q ha^{-1}) and it was on par with spacing of 30 X 15 cm (5.8 and 9.1 q ha^{-1}, respectively) (Table 2). This was mainly due to more efficient use of light in photosynthesis, better resource availability and reduced interplant competition in the community. Increase in grain yield was due to increase in yield attributes *viz.*, number of clusters per plant, seeds per cluster and test weight. At spacing of 30 X 10 cm recorded significantly more number of clusters per plant (5.2), seeds per cluster (8.3) and test weight (25.4 g) compared to 30 X 15 cm and 30 X 20 cm. The impact of row spacing on yield varies depending on the growing season of rainfall. Narrow row spacing recorded significantly higher moisture content in comparison to wide row spacing as former spacing reduced evaporation by increasing the rate of canopy closure (Anjhu Jeorge, 2014).The improvement in grain production with narrow row spacing could be attributed to higher planting density. Planting at a spacing of 30 X 10 cm recorded significantly higher grain yield compared to 30 X 20 cm. This increase in yield due to lesser spacing can be attributed to more plant population per unit area, which also reflected in higher values of growth attributing parameters *viz.* plant height and leaf area index and yield parameters like clusters per plant, seeds per cluster and 1000 grain weight. Similar results were reported by Paynter (2010), Kleemann and Gill (2010) and Anjhu Jeorge, (2014) in barley.

Nutrient supply is one of the most important factors that determines the growth of the crop. Fertilizer is the major plant food required in sufficient quantity. The response of crop to fertilizers varies widely from place to place, depending upon the native fertility level of soil, environmental condition and genotype. Among the nutrient levels, significantly taller plant height (75.0 cm) and higher LAI (2.5) (Table 1) was observed in the application of 35:20:20 NPK kg ha^{-1} and it was on par with the application of 35:15:15 NPK kg ha^{-1} this was due to higher uptake of nitrogen and phosphorus (Yadravi and Angadi, 2015). Increase in LAI was closely attributed due to higher leaf area per plant and number of leaves per plant. This is directly related to the higher plant height (Karki *et al.*, 2005 and Arun Kumar *et al.*, 2007).

Data regarding primary branches plant -1, nodes plant-1 and petiole length of common buck wheat as affected by various nitrogen and phosphorus levels is presented in Table 1. The table shows that nitrogen and phosphorus levels affected number of primary branches plant^{-1} nodes plant^{-1} and petiole length of buckwheat significantly. Maximum number of primary branches plant^{-1} (5.7), nodes plant^{-1} (20.4) and petiole length (6.6 cm) was produced in plots which received 35:20:20 NPK kg ha^{-1} and it was on par with application of 35:15:15 NPK kg ha^{-1} (5.4, 18.3 and 6.2 cm, respectively).

Table.1 Effect of spacing and nutrient levels on plant height, LAI, primary branches plant^{-1}, nodes plant^{-1} and petiole length of buck wheat.

Treatment	Plant height at harvest (cm)	LAI	Primary branches plant $^{-1}$	Nodes plant $^{-1}$	Petiole length (cm)
Main plot – Spacing (S)					
30 X 10 cm (S1)	73.2	2.3	5.6	19.5	6.2
30 X 15 cm (S2)	71.5	2.1	5.1	18.0	6.0
30 X 20 cm (S3)	68.0	1.7	4.5	14.7	5.6
S.Em ±	**0.87**	**0.07**	**0.17**	**0.89**	**0.10**
CD@ 5%	**3.41**	**0.28**	**0.68**	**3.49**	**0.39**
Sub plot – Fertilizer (F)					
35:20:20 NPK kg ha^{-1} (F1)	75.0	2.5	5.7	20.4	6.6
35:15:15 NPK kg ha^{-1} (F2)	73.0	2.2	5.4	18.3	6.2
25:10:10 NPK kg ha^{-1} (F3)	64.7	1.4	4.1	13.5	5.0
S.Em ±	**2.66**	**0.26**	**0.42**	**1.34**	**0.40**
CD@ 5%	**8.20**	**0.80**	**1.28**	**4.13**	**1.23**
Interaction – S X F					
S1F1	77.6	3.0	6.3	22.1	7.0
S1F2	75.3	2.5	6.0	20.9	6.5
S1F3	66.7	1.5	4.5	15.5	5.2
S2F1	75.7	2.6	5.9	21.5	6.6
S2F2	73.2	2.3	5.4	18.5	6.3
S3F3	65.6	1.3	4.2	14.1	5.0
S3F1	71.6	2.1	5.1	17.6	6.1
S3F2	70.4	1.9	4.8	15.5	5.9
S3F3	61.9	1.3	3.5	10.9	4.7
S.Em ±	**4.61**	**0.45**	**0.72**	**2.32**	**0.69**
CD@ 5%	**NS**	**NS**	**NS**	**NS**	**NS**

Table.2 Effect of spacing and nutrient levels on clusters per plant, seeds per cluster, test weight, grain yield and straw yield of buck wheat

Treatment	Clusters per plant	Seeds per cluster	1000-seed weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Main plot – Spacing (S)					
30 X 10 cm (S1)	5.2	8.3	25.4	6.2	10.3
30 X 15 cm (S2)	4.9	8.2	23.9	5.8	9.1
30 X 20 cm (S3)	4.3	7.6	22.0	4.4	7.6
S.Em ±	**0.09**	**0.11**	**0.52**	**0.35**	**0.44**
CD@ 5%	**0.33**	**0.43**	**2.06**	**1.36**	**1.72**
Sub plot – Fertilizer (F)					
35:20:20 NPK kg ha^{-1} (F1)	5.0	8.5	26.6	6.0	10.2
35:15:15 NPK kg ha^{-1} (F2)	4.9	8.1	25.1	5.7	9.3
25:10:10 NPK kg ha^{-1} (F3)	4.4	7.4	19.6	4.6	7.5
S.Em ±	**0.14**	**0.22**	**1.56**	**0.33**	**0.38**
CD@ 5%	**0.44**	**0.69**	**4.80**	**1.01**	**1.19**
Interaction – S X F					
S1F1	5.3	8.8	28.4	6.9	11.6
S1F2	5.4	8.5	26.1	6.4	10.7
S1F3	4.9	7.5	21.6	5.2	8.5
S2F1	5.1	8.8	26.6	6.4	10.5
S2F2	5.0	8.2	25.6	6.1	9.1
S3F3	4.5	7.5	19.4	5.0	7.8
S3F1	4.5	8.0	24.7	4.8	8.4
S3F2	4.4	7.6	23.6	4.7	8.2
S3F3	3.9	7.2	17.8	3.6	6.4
S.Em ±	**0.25**	**0.39**	**2.70**	**0.57**	**0.67**
CD@ 5%	**NS**	**NS**	**NS**	**NS**	**NS**

While the lowest number of branches plant^{-1} (4.1), nodes plant^{-1} (13.5) and petiole length (5.0) was recorded in plots where 25:10:10 NPK kg ha^{-1} was applied.

Grain yield and straw yield of common buckwheat as affected by nitrogen and phosphorus levels is shown in Table 2. The table shows that various N and P levels affected grain yield of buckwheat significantly. Significantly higher grain and straw yield (6.0 and 10.2 q ha^{-1}, respectively) was produced in plots which received 35:20:20 NPK kg ha^{-1} and it was on par with application of 35:15:15 NPK kg ha^{-1} (5.7 and 9.3 q ha^{-1}, respectively) while the lowest grain and straw yield (4.6 and 7.5 q ha -1, respectively) was produced in plots in which 25:10:10 NPK kg ha^{-1} was applied. This was due to significant increment in yield attributes *viz.*, more number of clusters per plant (5.0), seeds per cluster (8.5) and test weight (26.6 g). These results are in concurrence with the findings of Noworolink, (1995). The higher grain and straw yield of buckwheat was mainly due to better translocation of photosynthates from source to sink and higher growth and yield attributing characters. Increase in yield may be attributed to application of nitrogen accelerated the photosynthetic rate resulted in the improvement of growth and yield components (Shah Khalid *et al.*, 2015). The increase in number of clusters per plant attributed due to nitrogen involved in energy transformations, activation of enzymes in carbohydrate metabolism and consequently greater transformation of photosynthates into reproductive parts (Mohammadi *et al.*, 2015 and Zhang *et al.*, 2013). Interaction effects were non-significant with respect to planting density, genotypes and nutrient management.

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