Response of levels of nitrogen and row spacing on growth and leaf yield of palak (*Beta vulgaris var. bengalensis*) var. Arka Anupama

Abstract

A field experiment was ~~laid out and~~ conducted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, with a view to study the response of levels of nitrogen and row spacing on growth and leaf yield of palak (*Beta vulgaris var. bengalensis*) var. Arka Anupama during *Rabi* season of the year 2019-20 with factorial randomized block design (FRBD) along with three replication. The study was conclude that the application of Nitrogen @ 100 ~~kg/ha~~ kgha^{-1}(N_3) gave maximum shoot length (29.24 cm), maximum number of leaves (13.37), maximum leaf area (91.02 cm^2), chlorophyll content SPAD value (37.10), ascorbic acid content (76.47 mg) at first cutting, maximum fresh leaf weight i.e. 57.88, 52.77, 48.23 and 38.33 g and maximum dry leaf weight i.e. 6.50, 6.24, 5.81 and 4.92 g at 1st, 2nd, 3rd and 4th cutting respectively and maximum leaf yield per plot (20.90 kg) and per hectare (37.32 t) while ~~incase~~ in case of row spacing, S_3 (40 cm) gave maximum number of leaves (13.44), maximum leaf area (89.69 cm^2) at first cutting, maximum fresh leaf weight i.e. 56.63, 51.92, 46.30 and 36.67 g and maximum dry leaf weight i.e. 6.41, 6.20, 5.82 and 4.75 g at 1st, 2nd, 3rd and 4th cutting respectively while, maximum number of plants/sq.m at 10 DAS (47.05), shoot length (28.98 cm), green leaf yield per plot (20.68 kg) and per hectare (36.93 t) observed in treatment S_1 (20 cm)

Introduction

Palak (*Beta vulgaris var.bengalensis*) is one of the most important leafy vegetables of tropical and sub-tropical regions. It is also known by other name like leaf beet, beet palak and spinach beet. It is closely related to beetroot (*Beta vulgaris*) and Swiss chard (*Beta vulgaris var. cicla*) and good substitute for spinach. Palak has a nutritional as well as medicinal value. Green leafy vegetables occupy an important among the food crops as these provide adequate amounts of many vitamins and minerals for humans. Amongst all the vegetables, the leafy vegetables have high protective food value. They are rich in mineral and hence called as 'mines of minerals'. Vitamin A and C are present in abundant quantities. Beside this, soft fibrous matter is specially providing necessary roughage in diet. It is widely grown leafy vegetable. The leaves are used in inflammation, paralysis, headache and remedy for liver disease. Besides its medicinal property it also acts as mild laxative. Palak neutralize the acidity produced during digestion of fatty substance and help to prevent constipation. Indian spinach is used as fresh vegetables for cooking and also in salad form. It contains moisture 86.49 %, fiber 0.7 g, protein 3.4 g, minerals 2.2 g, carbohydrates 6.5 g, riboflavin 0.5 g, calcium 380 mg, iron 16.2 mg, thiamin 0.26 g, Vitamin A 9770 IU, Vitamin C 70 mg/ 100g of edible portion (Vishnu, 2014).

Commented [GG1]: Where?? Your title should be informative!

Commented [GG2]: As you know/should know: Abstract should be self-explanatory, but yours is not!
So, re-write the whole section to be accepted!

Commented [GG3]: Delete it

Commented [GG4]: What does it mean?

Commented [GG5]: Replications.

Commented [GG6]: Where are the treatment-set up. An abstract should be self-explanatory

Commented [GG7]: Why don't you start with conclusion???
Instead say, the study revealed that the application of……

Commented [GG8]: @ is not common in scientific writing. Omit it!

Commented [GG9]: Put comma before respectively.

Commented [GG10]: Why don't you utilize period/full stop between the sentences? Punctuation is very important to the clarity of writing!
Your writing ends with: SO WHAT????
What's your conclusion???
What's your recommendation??

Commented [GG11]: Big problems/issues:
1.Lack of source/s?? this is an introduction, and should support your writing with sufficient sources. I've got only two sources throughout the whole section! you didn't review related literatures!
2. Lack of consistency?? The second paragraph should be the continuation of the first one, you should not start any paragraph in between.
3. Minimize the number of paragraphs, merge them!

The several factors like judicious fertilization and use of optimum amount of quality seed play an important role in crop production. Spinach beet being a green leafy vegetable may need heavy nitrogen fertilization but its exact requirement not known and hence it is to be examined.

Nitrogen in general increases the vegetative growth but depresses the root growth. Excess of nitrogen strongly stimulates the plant to synthesize proteins and to develop fresh vegetative tissues and the bulk of the carbohydrates is used for the formation of amino acid and proteins and the construction of strengthening tissues, inconsequence to become a spongy, tender and dark green.

Nitrogen is the essential for the vegetative growth of the plant resulting in higher green leaf yield. An ample supply of nitrogen not only helps in the production of succulent leafy matter in all leafy vegetable but in their seed production also. The yield of palak depends on vegetative growth and it may express in terms of number of leaves per plant, size of leaf and plant height etc. For obtaining more vegetative growth cutting of crop is important due to cutting of crop side shoots are arises which increases the number of leaves per plant and ultimately increased the yield which demands higher amount of nitrogen.

Spacing between rows of plants is another factor that affects the growth and yield of the crop. Evapotranspiration and weed infestation were found high in the crop grown with wider spacing and hence it is necessary to grow the crop at optimum spacing (Rahman & Talukdar 1986). In palak not only planting geometry but also nutrient management practices play a vital role in boosting up its productivity. Optimum row spacing facilitates better utilization of nutrient resources supplied through inorganic fertilizers.

Materials and methods

Present experiment was conducted in open field condition at Horticultural Research Farm, Department of Horticulture. B. A. College of Agriculture, A. A. U., Anand during *Rabi* season of the year 2019-20 in which efforts were made to investigate the growth and leaf yield of palak with different levels of nitrogen and row spacing. The experiment was layout in Factorial Randomized Block Design (FRBD) with three replications. Three levels of nitrogen *viz.*, 60 kg N/ha (N_1), 80 kg N/ha (N_2) and 100 kg N/ha (N_3) and three row spacing *viz.*, 20 cm (S_1), 30 cm (S_2) and 40 cm (S_3) comprising total nine treatment combinations were taken for experiment. Half dose of N as per treatment was applied in form of urea at the time of planting and remaining half dose of nitrogen was applied ~~at~~ after each cutting or harvesting of the leaves. The fertilizer dose of phosphorus and potassium were applied as basal dose at time of planting. Ten plants per treatment plot were observed and recorded for growth and yield characteristics. The collected data for all studied characteristics were statistically analyzed using the factorial Randomized Block Design (FRBD) method as per guidelines.

3. Result and discussion

3.1. Growth parameters

3.1.1. **Number of plants~~/ m² at 10 days after sowing~~**

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Commented [GG14]: But also in their seed production!

Commented [GG15]: My friend, what does it mean etc?? in scientific community etc is not acceptable. If you have additional factors mention them.

Commented [GG16]: What's the gap??
What's your objective/s?
Why don't you present previous works on this crop, or you are the first author who conducted a study on this crop??

Commented [GG17]: Where are the sub-sections??
You didn't say anything about:
- land preparation??
- Stage of harvesting??
- Cutting frequency??
- Plot/Plant management??
- Soil analysis: before and after?
- Plat analysis?

The success of any paper depends on this section! I couldn't understand how you conducted the study??

Commented [GG18]: Do you think this is the right place?? It seems an objective??

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Commented [GG21]: Using what statistical software???
Randomized block is a design not a statistical software??

Commented [GG22]: My expectation throughout this section
1.Effect of spacing on each response variable?
2. Effect of nitrogen on each response variable?
3. Interaction effect of both factors on each response variable ??
4. Discuss your results in comparison with the previous studies?
5.Partial budget analysis?

But:
1.You couldn't present your findings well
2. Couldn't discuss in comparison with the literature?

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Commented [GG24]: It seems a sentence, not a title! "Number of plants" is enough! the rest put under methodology

Commented [GG25]: Your title says " Result and Discussion, but even you couldn't present your complete result??

Number of plants/ m^2 at 10 days after sowing was found non significant effect with respect to different levels of nitrogen. Among the row spacing treatment S_1 (20 cm) found significant. This might be due to closer spacing increase the number of plants. The results are in conformity with the findings of Snider *et al.* (2012) in sorghum.

2. Shoot length ~~at first cutting~~

Shoot length was significantly affected due to various levels of nitrogen. Maximum shoot length (29.24 cm) was observed in treatment N_3 (100 kg N/ha). This might be due to the fact that, nitrogen which is vital nutrient compound and a major constituent of chlorophyll, chief constituent of protein, essential for the formation of protoplasm which help in stimulating the cell division and cell elongation which leads increased plant height and growth. The results are closely relevant to the findings of Sharma *et al.* (2016) in coriander. While among the row spacing maximum shoot length (28.98 cm) was observed in treatment S_1 (20 cm**),** which was at par with treatment S_2 (27 cm). This might be due to more plant population per unit area which resulted in more competition for sunlight leading to more up right growth in search of sunlight. The results are in conformity with the findings of Zibelo *et al.* (2016) in okra.

3. Number of leaves/plant ~~at first cutting~~

Number of leaves/plant at first cutting was significantly affected by the different levels of nitrogen. Maximum number of leaves (13.37) observed in treatment N_3 (100kg N/ha), which was at par with treatment N_2 (13.05) it might be due to higher level of nitrogen imparts the vigorous vegetative growth which resulting in increased number of leaves per plant. Similar, results are also reported by Ali *et al*. (2016) in spinach and Anupama *et al.* (2017) in fenugreek. Among the row spacing maximum number of leaves (13.44) observed in treatment S_3 (40 cm), which was at par with treatment S_2 (12.82) it might be due to plants get sufficient space for vegetative growth, faced no competition for the sunlight which resulted in more vegetative growth which expressed in production of more number of leaves per plant. Similar, results were also reported by Patel *et al.* (2011) in amaranthus.

4. Leaf area (cm^2) per plant at first harvest

As regards to leaf area (cm^2) per plant at first harvest nitrogen @100 kg/ha (N_3) recorded significantly highest leaf area (91.02 cm^2) of palak followed by N_2 (82.56 cm^2) it might be due to the quick availability of nitrogen to the plants, nitrogen imparts the vigorous vegetative growth which leads to the cell division and cell enlargement. Similar, results were also reported by Singh *et al.* (2015) in palak and Elsayed and Abdelraouf (2008) in spinach. With regards to leaf area at first cutting showed significantly, maximum leaf area (89.7 cm^2) in treatment S_3 (40 cm), which was at par with treatment S_2 (82.33 cm^2) that might be due to more favourable condition with better uptake of nutrients, water and efficient utilization of sunlight. Similar, results were also recorded by Patel *et al.* (2011) in amaranthus.

5. Fresh leaf weight (g) at each cutting

With respect to fresh leaf weight at 1^{st}, 2^{nd}, 3^{rd} and 4^{th} cutting nitrogen @100 kg/ha (N_3) found significantly maximum fresh leaf weight i.e. 57.88, 52.77, 48.23 and 38.33 g respectively which was at par with N_2 (80 kg/ha) at 1^{st}, 2^{nd}, 3^{rd} and 4^{th} cutting that might be due to the fact that nitrogen is the vital

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component of protein which promotes cell division and as the level of nitrogen increases, it promotes the vigorous cell division and accumulation of more plant metabolites. Similar, trends in results were also observed by Sharma *et al.* (2016) in coriander and Anupama *et al.* (2017) in fenugreek. With regards to row spacing fresh leaf weight at 1st, 2nd, 3rd and 4th cutting treatment S_3 (40 cm) recorded significantly maximum fresh leaf weight i.e. 56.63, 51.92, 46.30 and 35.71 g respectively which was at par with S_2 (30 cm) at 1st, 2nd, 3rd and 4th cutting that might be due to the fact that plant receive enough light and nutrients which leads to attain maximum fresh weight of leaves. Similar, results were also reported by Patel *et al.* (2011) in amaranthus.

5. Dry leaf weight (g) at each cutting

With respect to dry leaf weight at 1st, 2nd, 3rd and 4th cutting nitrogen @100 kg/ha (N_3) found significantly maximum dry leaf weight i.e. 6.50, 6.24, 5.81 and 4.92 g respectively which was at par with N_2 (80 kg/ha) at 1st, 2nd, 3rd and 4th cutting that might be due to higher level of nitrogen helps in vigorous vegetative growth and accumulation of more photosynthetic product in the plants. On drying plants with healthy and vigorous growth resulted in maximum dry matter than that of plants with lower levels of nitrogen. Similar, results were also reported by Biemond (2004) and Pujari (2017) in spinach. With regards to row spacing dry leaf weight at 1st, 2nd, 3rd and 4th cutting treatment S_3 (40 cm) recorded significantly maximum dry leaf weight i.e. 6.41, 6.20, 5.82 and 4.75 g respectively which was at par with S_2 (30 cm) at 1st, 2nd, 3rd and 4th cutting that might be due to plants get sufficient space for vegetative growth, faced no competition for the sunlight which resulted in more vegetative growth which expressed in production of more number of leaves per plant and thereby increase the fresh leaf weight and upon drying increase the dry weight of leaves. These results are closed to finding of Patel *et al.* (2011) in amaranthus.

YIELD PARAMETERS

6. Green leaf yield (kg/plot)

Nitrogen @100 kg N/ha (N_3) recorded significantly highest green leaf yield per plot (20.90 kg) that might be due to nitrogen play a role of stimulant in metabolic activity which leads to the cell division and cell enlargement and probably increased the number of leaves, leaf area and fresh weight of leaves which finally lead to increased green leaf yield per plot and per hectare. The result was in confi rmly with Anupama *et al.* (2017) in fenugreek, Datta *et al.* (2008) in coriander and Elsayed & Abdelraouf (2008) in spinach. With regards to row spacing highest green leaf yield per plot (20.68 kg) was observed in treatment S_1 (20 cm) that to be fact that in close spacing there was more number of plants per unit area of land. As the plants per unit area were increased the green yield per plot increased significantly. The results are in accordance with finding of Essilfie *et al.* (2017) in chilli and Assefa *et al.* (2015) in tomato.

7. Green leaf yield (t/ha)

Nitrogen @100 kg N/ha (N_3) recorded significantly highest green leaf yield per hectare (37.32 t/ha) With regards to row spacing highest green leaf yield per hectare (36.93 t/ha) was observed in treatment S_1 (20 cm).

Conclusion

On the basis of the present investigation, it can be concluded that application of 100 kg N/ha should be given for getting higher green leaf yield and also keep row spacing of 20 cm was ideal for getting higher green leaf yield.

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-Grammatical error,
-Lack of enough Literature
-Poor/unclear methodology,
-Lack of consistency
- Poor presentation of the results
-Poor discussion,
I can conclude that it's better to re-write the whole paper!

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Table 1 : Variability in factors in different treatment efficacy

Treatments	Number of plants/ m^2	Shoot length (cm)	Number of leaves/plant	Leaf area (cm^2)	Green leaf yield kg/plot	Green leaf yield t/ha
Factor A : Nitrogen						
N_1 : **60 kg/ha**	34.76	25.79	11.55	74.01	17.91	31.98
N_2 : **80kg/ha**	34.27	27.01	13.05	82.56	18.46	32.97
N_3 : **100 kg/ha**	33.77	29.24	13.37	91.02	20.90	37.32
S. Em.±	1.14	0.73	0.40	3.47	0.64	1.14
C. D. at 5 %	NS	2.19	1.21	10.42	1.92	3.43
Factor B : Row spacing						
S_1 : **20 cm**	47.05	28.98	11.70	75.57	20.68	36.93
S_2: **30 cm**	31.76	27.00	12.82	82.33	18.69	33.38
S_3: 40 cm	23.98	26.06	13.44	89.69	17.90	31.96
S. Em.±	1.14	0.73	0.40	3.47	0.64	1.146
C. D. at 5 %	3.43	2.19	1.21	10.42	1.92	3.436
Interaction						
N× S	NS	NS	NS	NS	NS	NS
C.V. %	10.04	8.03	9.63	12.63	10.09	10.09

Table 2 : Variation in Fresh leaf weight (g) in different treatment efficacy

Treatments	Fresh leaf weight (g)			
	At 1st cutting	At 2nd cutting	At 3rd Cutting	At 4th Cutting
Factor A : Nitrogen				
N_1 : 60 kg/ha	51.35	44.22	38.44	31.89
N_2 : 80kg/ha	54.89	47.61	42.93	33.34

N_3 : 100 kg/ha	57.88	52.77	48.23	38.33
S. Em.±	1.33	1.74	2.02	1.35
C. D. at 5 %	3.99	5.23	6.07	4.07
Factor B : Row spacing				
S_1 : 20 cm	51.66	45.02	37.49	31.18
S_2 : 30 cm	55.84	47.66	45.82	35.71
S_3 : 40 cm	56.63	51.92	46.30	36.67
S. Em.±	1.33	1.74	2.02	1.35
C. D. at 5 %	3.99	5.23	6.07	4.07
Interaction				
N × S	NS	NS	NS	NS
C. V. %	7.30	10.86	14.06	11.80

Table 3: Variation in Dry leaf weight (g) in different treatment efficacy

Treatments	**Dry leaf weight (g)**			
	At 1st cutting	**At 2nd Cutting**	**At 3rd Cutting**	**At 4th Cutting**
Factor A : Nitrogen				
N_1 : 60 kg/ha	5.20	5.09	4.61	4.01
N_2 : 80kg/ha	5.90	5.80	5.48	4.38
N_3 : 100 kg/ha	6.50	6.24	5.82	4.92

S. Em.±	0.26	0.23	0.24	0.19
C. D. at 5 %	0.79	0.69	0.74	0.59
Factor B : Row spacing				
S_1 : 20 cm	5.40	5.22	4.83	4.01
S_2 : 30 cm	5.79	5.71	5.26	4.54
S_3 : 40 cm	6.41	6.20	5.81	4.75
S. Em.±	0.26	0.23	0.24	0.19
C. D. at 5 %	0.79	0.69	0.74	0.59
Interaction				
N × S	NS	NS	NS	NS
C. V. %	13.60	10.86	14.06	13.33