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Correlational Study on the Relationship between Plant Growth, Seed Yield and Quality Related Traits in Palak under Bundelkhand Region

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ABSTRACT: An experiment was conducted at the Vegetable Research Farm of the College of Horticulture, BUAT, Banda during the Rabi (October-March) season of 2020-21 to determine the relationship between the characteristics affecting plant growth, seed yield and quality in Palak. Bundelkhand is a drought-prone region with water scarcity and high temperatures, water tankers and tanks were used for irrigation. The experiment used a Factorial Randomize Block Design with two variables: row spacings (S) and micronutrient treatments (M). The first factor, row spacings, included 30 × 10 cm (S1), 40 × 10 cm (S2), and 50×10 cm (S3) treatments, while the second factor, micronutrient application, included four treatments: no micronutrients (M0), Zink Sulphate Monohydrate @ 20kg/ha (M1), Disodium Octaborate Tetrahydrate@ 20kg/ha (M2) and an equal quantity of each Zink Sulphate Monohydrate, Disodium Octaborate Tetrahydrate with a commercial formulation containing Zn, Fe, Cu and Mn @10kg/ha (M3) in variety of Palak (All Green). The treatments under both the factors were applied in all possible combinations in three replications. Correlation coefficient values indicated that seed yield showed either non-significant positive or negative correlation with all the parameters of plant growth, seed yield and seed quality. In contrast, the major seed quality parameter i.e., germination percentage displayed significant positive correlation with most of the traits viz., plant height, dry weight of plants, days to 50% flowering, number of spikes per plant, spikelet length, spike length, 100 seed weight, seedling dry weight, seedling root length, seedling shoot length, total seedling length, seedling vigour index-I and seedling vigour index-II.

Keywords: Palak, Correlation, Micronutrients, Spacings, Yield.

INTRODUCTION

Palak (*Beta vulgaris* var. *bengalensis* L.) is a well-known member of Chenopodiaceae family of leafy vegetables. Its other names include garden beetroot, Palongpalang, Sag, Indian spinach and spinach beetroot. It was probably first discovered in China around 647 AD and is native to the Indochinese regions (Salaria and Salaria 2009). Chromosome number 2n=2x=18 describes this. Palak is one of the green vegetables most commonly grown in India. In tropical and subtropical regions, it is commonly grown. Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, West Bengal, Delhi, Haryana and Punjab are some of the most well-known growing states in India. In India, palak is frequently grown during the cooler months. Palak is often grown during the cooler months because it is a cool-season vegetable widely grown in India (Thamburaj and Singh 2015). Its sensitive, soft, juicy leaves are used in cooking. It contains a lot of vitamin A and vitamin C. It also contains 30 mg of phosphorus, 380 mg of calcium, 16.2 mg of iron, 3.4 g of protein, 46 Kcal of energy, 0.8 g of fat, 6.5 g of carbohydrates, 0.26 mg of thiamine and 0.56 mg of riboflavin per 100 g of edible part (Singh *et al*., 2015). Palak has also been linked to the treatment of micro and macronutrient deficits, degenerative disease and cancer (Grubben, 1977). The information on spacing and number of leaf cuttings for higher green and seed yield is available in certain parts of the country (Lal *et al.*, 1979; Singh and Gill 1983; Phor and Mangal 1991). However, no recommendations have been made on plant geometry and nutrient management for quality seed production in palak in Bundelkhand region.

Correlation coefficient analysis measures the inter-relationship between different plant traits and determines the component traits based on which selection can be made to improve yield (Fisher, 1918). Correlation study clearly revealed that 100 seed weight significantly associated to the seed yield (Chattopadhyay *et al*., 2011). A highly significant correlation between tuber content of chemical parameters was determined and was conditioned most importantly by manganese andiron for the French Fries variety of potato and by copper, zinc and manganese for the Crisp variety (Gaj *et al*., 2020). Plant density, seed yield was negatively correlated with row spacing (Asher *et al.* 2022). Fruit yield in sponge gourd was significantly and positively correlated with plant height (Chitra *et al*., 2023). Seed yield is a complex trats which is affected by many quantitative characters. The main objective of this research to increase the profit of farmers for providing quality seed yield with suitable row-spacings and micronutrients in palak.

MATERIALS AND METHODS

The experiment was conducted at the Vegetable Research Farm of the College of Horticulture, BUAT, Banda during the Rabi (October-March) season of 2020-21. The soil of the experimental farm is parua type with organic matter more than 0.45% and pH range 7.2 to 7.6. parua soil is a mixture of black and red-yellow soil and can be identified by its light red or yellow-red colour. Row spacings (S) and micronutrients (M) were the two parameters used in the layout of Factorial Randomized Block Design The first factor *i.e*. row-spacings included 30x10 cm (S_1), 40x10 cm (S_2) and 50x10 cm (S_3) whereas, the second factor *i.e*., micronutrient application included four treatments *viz.*, without micronutrients (M_0), Zink Sulphate Monohydrate (33% Zn+15% S) @ 20kg/ha (M_1), Disodium Octaborate Tetrahydrate (20% B) @ 20kg/ha (M_2) and equal quantity of each Zink Sulphate Monohydrate (33% Zn+15% S), Disodium Octaborate Tetrahydrate (20% B) with a commercial formulation containing 6.0% Zn, 3.0% Fe, 0.5% Cu and 1.5% Mn @10kg/ha (M_3) in 'All Green' variety of Palak. We used all possible combinations of different treatments related to both factors in three separate replications. Palak seeds were sowing on 20 November (2020). Later, to check that the plants maintained the required distance as per the treatment, some plants were removed for thinning. We used farmyard manure (FYM) at a rate of 10 metric tons per hectare and 120 kg nitrogen, 50 kg phosphorus and 40 kg potassium per hectare (NPK) fertilizers in each treatment group. The full quantity of Farm Yard Manure (FYM), phosphorus, and potassium along with half nitrogen was applied during the final ploughing session. On the other hand, the entire supply of micro-nutrients was made during the weeding-cum-hoeing process, which took place 20 days after sowing. A quarter of the nitrogen was applied 28 days after sowing and after the next third irrigation, while the remaining one-fourth of the quantity of nitrogen is applied in the last stage, preferably 55 days after sowing. Once the spikes turned turned yellow, it was time to harvest, which involve hand threshing followed by winnowing and sieving to separate and clean the seeds. The biometric observations of plant growth, seed yield and quality parameters like plant height (cm), number of leaves per plant, leaf area (cm^2), dry weight of plants (g) days to fifty percent flowering (days after sowing, DAS) number of spikes per plant, spike length (cm), spikelet length (cm), 100 seed weight (g), seed yield (q/ha) germination percentage, seedling shoot length (cm), seedling root length (cm), total seedling length (cm), seedling dry weight (mg), seedling vigour index-I and seedling vigour index-II were documented by different procedures.

The following formula was used to calculate the seed yield per hectare based on the seed yield of palak got in each plot.

$$\text{Seed yield per hectare (q)} = \frac{\text{Seed yield per plot (kg)} \times 10,000\text{m}^2}{\text{Net plot area (m}^2) \times 100}$$

The gathered data were analyzed statistically and analysis of variance was conducted using the recommended methodology outlined by Panse and Sukhatme (1978); Sundararaj *et al*. (1972). The ANOVA table and correlation suggested for a two-factor randomized block design was employed to test for significant differences among the treatments using both MS Excel and OPSTAT software.

RESULT AND DISCUSSION

Correlation coefficients between plant growth, seed yield components and seed quality parameters in all possible combinations were calculated and presented in Table 1. The results of correlation values between different traits can be described as follows:

The plant height was positively and significantly correlation with days to 50% flowering (r = 0.756**), number of spikes per plant (r = 0.800**), 100 seed weight (r = 0.658*), germination percentage (r = 0.590*), seedling shoot length (r = 0.660*), seedling root length (r = 0.662*), total seedling length (r = 0.715**), seedling dry weight (r = 0.655*), seedling vigour index I (r = 0.692*) and seedling vigour index II (r = 0.665*). The leaf area was significantly and positively correlated with number of spikes per plant (r = 0.718**). Whereas, dry weight of plants was significantly and positively correlated with spike length (r = 0.558*), spikelet length (r = 0.675*), 100 seed weight (r = 0.636*), germination percentage (r = 0.588*), seedling root length (r = 0.656*), seedling vigour index I (r = 0.601*) and seedling vigour index II (r = 0.595*). There was significant and positive correlation of days to 50% of flowering with spikelet length (r = 0.780**), 100 seed weight (r = 0.805**), germination percentage (r = 0.804**), seedling shoot length (r = 0.786**), seedling root length (r = 0.899**), Total seedling length (r = 0.917**), seedling dry weight (r = 0.897**), seedling vigour index I (r = 0.895**) and seedling vigour index II (r = 0.895**).Number of spikes per plant exhibited significantly positive correlation with spikelet length (r = 0.690*), germination percentage (r = 0.637*), seedling shoot length (r = 0.602*), total seedling length (r = 0.578*) and seedling vigour index I (r = 0.614*).

Table 1: Correlation coefficient between plant growth characters, seed yield components and seed quality parameters in all combination of Palak.

Characters	Plant height (cm)	No. of leaves/plant	Leaf area (cm^2)	Dry weight of plant (g)	Days to 50% flowering	No. of spikes/plant	Spike length (cm)	Spikelet length (cm)	100 seed weight (g)	Germination percentage	Seedling shoot length (cm)	Seedling root length (cm)	Total seedling length (cm)	Seedling dry weight (g)	Seedling vigour index I	Seedling vigour index II	Seed yield(q/ha)
Plant height (cm)	1.000																
No of leaves/plant	-0.037	1.000															
Leaf area (cm^2)	0.362	0.139	1.000														
Dry weight of plant (g)	0.561	0.316	0.235	1.000													
Days to 50% flowering	0.756**	0.049	0.363	0.577*	1.000												
No of spikes/plant	0.800**	0.115	0.714**	0.452	0.562	1.000											
Spike length (cm)	0.500	-0.201	0.432	0.588*	0.354	0.528	1.000										
Spikelet length (cm)	0.741**	-0.052	0.253	0.675*	0.780**	0.690*	0.491	1.000									
100 seed weight (g)	0.698*	0.307	0.234	0.636*	0.805**	0.465	0.461	0.650*	1.000								
Germination percentage	0.590*	0.065	0.472	0.588*	0.804**	0.637*	0.635*	0.835**	0.777**	1.000							
Seedling shoot length (cm)	0.660*	0.058	0.457	0.352	0.786**	0.602*	0.387	0.644*	0.733**	0.778**	1.000						
Seedling root length (cm)	0.662*	0.278	0.262	0.656*	0.899**	0.502	0.424	0.756**	0.941**	0.876**	0.773**	1.000					
Total seedling length (cm)	0.715**	0.188	0.362	0.574	0.917**	0.578*	0.435	0.759**	0.909**	0.881**	0.914**	0.962**	1.000				
Seedling dry weight (g)	0.655*	0.222	0.211	0.566	0.897**	0.457	0.382	0.731**	0.943**	0.860**	0.819**	0.988**	0.974**	1.000			
Seedling vigour index I	0.692*	0.106	0.388	0.601*	0.895**	0.614*	0.552	0.829**	0.876**	0.960**	0.877**	0.952**	0.976**	0.954**	1.000		
Seedling vigour index II	0.665*	0.140	0.272	0.595*	0.895**	0.524	0.492	0.801**	0.914**	0.930**	0.831**	0.980**	0.973**	0.985**	0.987**	1.000	
Seed yield (q/ha)	-0.055	-0.436	0.352	-0.191	-0.122	0.179	-0.015	-0.053	-0.553	-0.147	0.028	-0.391	-0.233	-0.400	-0.202	-0.324	1.000

The spike length was significantly and positively correlated with germination percentage (r = 0.635*). Similarly, spikelet length showed highly significant and positive correlation with 100 seed weight (r = 0.650*), germination percentage (r = 0.835**), seedling shoot length (r = 0.644*), seedling root length (r = 0.756**), total seedling length (r = 0.759**), seedling dry weight (r = 0.731**), seedling vigour index I (r = 0.829**) and seedling vigour index II (r = 0.801**).The 100 seed weight was highly positive and significantly correlated with germination percentage (r = 0.777**), seedling shoot length (r = 0.733*), seedling root length (r = 0.941**), Total seedling length (r = 0.909**), seedling dry weight (r = 0.943**), seedling vigour index I (r = 0.876**) and seedling vigour index II (r = 0.914**).Germination percentage showed significant and positive correlation with seedling shoot length (r = 0.778**), seedling root length (r = 0.876**), total seedling length (r = 0.881**), seedling dry weight (r = 0.860**), seedling vigour index I (r = 0.960**) and seedling vigour index II (r = 0.930**). The seedling shoot length significantly positive correlation with seedling root length (r = 0.733**), total seedling length (r = 0.914**), seedling dry weight (r = 0.819**), seedling vigour index I (r = 0.877**) and seedling vigour index II (r = 0.831**). The seedling root length significantly positive correlation with total seedling length (r = 0.962**), seedling dry weight (r = 0.988**), seedling vigour index I (r = 0.952**) and seedling vigour index II (r = 0.980**). Total seedling length significantly and positively correlated with seedling dry weight (r = 0.974**), seedling vigour index I (r = 0.976**) and seedling vigour index II (r = 0.973**). Seedling dry weight exhibited significant and positive correlation with seedling vigour index I (r = 0.976**) and seedling vigour index II (r = 0.973**). Seedling vigour index I was significantly and positively correlation with seedling vigour index II (r = 0.987**). On the basis of correlation coefficient values it was evident that seed yield showed either negative or non-significant positive correlation with vegetative characters like plant height (r = -0.05), number of leaves per plant (r = -0.436), leaf area (r = 0.352), dry weight of plants (r = -0.191) and days to 50% flowering (r = -0.122), seed yield contributing traits like number of spikes per plant (r = 0.179), spike length (r = -0.015), spikelet length (r= -0.053) and 100 seed weight (r= -0.553) and seed quality parameters like germination

percentage (r = -0.147), seedling shoot length (r = 0.028), seedling root length (r= -0.391), total seedling length (r = -0.233), seedling dry weight (r = -0.400), seedling vigour index-I (r = -0.202) and seedling vigour index-II (r = -0.324). Contrarily, the principal seed quality parameter *i.e.*, germination percentage exhibited significant and positive correlation with most of vegetative characters *viz*., plant height (r = 0.590*), dry weight of plants (r = 0.588*) and days to 50% flowering (r = 0.804**), seed yield components *viz*., number of spikes per plant (r = 0.637*), spike length (r = 0.635*), spikelet length (r = 0.835**) and 100 seed weight (r = 0.777**) and seed quality parameters *viz*., seedling shoot length (r = 0.733**), seedling root length (r = 0.941**), total seedling length (r = 0.909**), seedling dry weight (r = 0.943**), seedling vigour index-I (r = 0.876**) and seedling vigour index-II (r = 0.914**). The parallel trend between germination percentage and vigorous plant growth, characteristics specifying bolder seeds and vigorous seedlings were observed in wider row-spacing, mostly attributable to the buildup of higher food stores in seeds produced with wider row-spacing

Biradar *et al*. (2006); Woldu *et al*. (2019); Thakur and Bhardwaj (2017) noted a consistent pattern in the relationship between germination percentage and various seed quality parameters when wider spacing was employed (Asher *et al.,* 2022) evaluated thirty-six correlation coefficients in sponge gourd, of which twenty-four displayed significant values. Spacing had a negative relationship with plant density and seed yield. Plant height was positively correlated with seed yield. The turnip study included eleven traits, of which eight traits showed a positive direct effect on seed yield per plant, with seed yield having the greatest positive effect, followed by plant height and days to 50% flowering, whereas there was a negative direct effect represented by 100 seed weight respectively (Mahendra *et al*., 2021). Painkra *et al.* (2018) studied on soybean and they estimated seed yield more significant and positive correlation with 100 seed weight and days to 50% flowering and also with plant height. Seed yield exhibited highly significant and positive associated with plant height. Whereas, days to 50 % flowering had exhibited positive correlation with seed yield/plant. 100 seed weight exhibited negatively correlated with seed yield/plant. However, plant height was negatively correlated with seed weight (Prajapati *et al*., 2022).

CONCLUSIONS

Correlation coefficient values indicated that seed yield showed either non-significant positive or negative correlation with all the parameters of plant growth, seed yield and seed quality. Contrarily, the principal seed quality parameter *i.e.*, germination percentage exhibited significant positive correlation with most of characters *viz*., plant height, dry weight of plants, days to 50% flowering, number of spikes per plant, spikelet length, spike length, 100 seed weight, seedling dry weight, seedling root length, seedling shoot length, total seedling length, seedling vigour index-I and seedling vigour index-II.

FUTURE SCOPE

The future scope of this study is to optimize the application of micronutrients with specific differences in spinach cultivation, considering environmental factors and their effects on plant growth, seed yield and quality, for sustainable and profitable fate.

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Conflict of Interest. None.

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