Original Research Article

Effect of Nano phosphorus on growth and yield of different varieties of groundnut (*Arachis hypogaea* L.) and yield validation using SPSS model

ABSTRACT

The experiment was conducted during the *Summer* season 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj (U.P.) to find out the "**Effect of Nano phosphorus on growth and yield of different varieties of groundnut (*Arachis hypogaea* L.) and Yield validation using SPSS model**". The experiment was laid out in Randomized Block Design comprising of 9 treatments which include 3 varieties Kadiri Lepakshi (K1812), Kadiri 6 (K6) and Kadiri 9 (K9) and 3 Different levels of nano phosphorous 2ml/litre, 4ml/litre and 6m/litre. Whose effect is observed in Ground nut varieties The result was observed in K-1812 by the application of nano phosphorus at the rate of 6 ml/lit was recorded maximum plant height (61.39 cm), plant dry weight (42.34 g/plant), number of pods per plant (32.87), seed index (42.09 g), pod yield (2.98 t/ha) and haulm yield (4.46 t/ha) and harvest index (40.07 %) were recorded in K-1812 with application of Nano phosphorus at the rate of 6 ml/lit respectively. At the same time higher gross return (1,25,307.00 INR/ha), net return (88,467.35 INR/ha) and benefit cost ratio (2.40).Treatment 3 has shown 42.28% increase over predicted yield where as there were 10.88% increase in treatment 7 over predicted yield through SPSS model.

KEYWORDS: Groundnut, yield, varieties, nano phosphorus, yield validation and SPSS.

Introduction

Ground nut belongs to family Leguminaceae and is fourth most important source of edible oil and third most important source of vegetable protein also known as "The King of Oilseeds" **(Priya *et al.*, 2022)**.

It is premier oil seed crop of India popularly known as peanut, monkey nut, manila nut. Globally 50% of groundnut is used for oil extraction, 37% confectionary and 12% seed purpose **(Nurezannat *et al.*, 2019)**. According to **Satish *et al.*, (2011),** groundnut is primarily used for extraction of oil, with an analysis of about 46.70%. It is also consumed directly because of its high food value, which is again due to its higher content of protein (22.0%), carbohydrate (10.0%) and minerals (3.0%).

Globally, Groundnut covers 315 lakh hectares with the production of 536 lakh tonnes with the productivity of 1701 kg per hectare **(FAOSTAT, 2020)**. With annual all-season coverage of 55.71 lakh hectares, globally, India ranks first in Groundnut area under cultivation and is the second largest producer in the world with 102 lakh tonnes with productivity of 1831 kg per hectare in 2020-21 (agricoop.nic.in). In Uttar Pradesh during 2019-20 groundnut covered an area of 93822 hectares with the production of 88.371 tonnes with the productivity of 940 kg per hectare**.**

The particles below 100 nm as nano-particles could make plants use fertilizer more efficiently, more environmentally friendly through hamper of pollution and, dissolve in water more effectively thus increase their absorption and distribution **(Zheng *et al.*, 2005)**. Therefore, nanotechnology such as using Nano scale fertilizer may offer new techniques to be used for crop management. Phosphorus plays an important role in Agricultural production. Agriculture is the major user of phosphorus resources (P), accounting for 80-90% of the world demand for P **(Gitari and Mureithi 2003)**.

Nanoparticles loaded with nutrients can enter root cells using different internationalization routes including joining to transport proteins through aquaporins and ionic channels, creating new pores, and by endocytosis **(Kurepa *et al.*, 2010)**.

Phosphorus (P) is part of amino acids, nucleic acids, phospholipids, and high-energy molecules such as adenosine triphosphate (ATP) **(Alcantar *et al.*, 2016)** in all living organisms. In plants, P is an essential element required for development and reproduction, and it is one of the main components of the fertilizers necessary to sustain modern agriculture. In soils, the concentration of inorganic P (available to plants) ranges from 35 to 70% of the total

P. This form of P shows low diffusion and high fixation rates in soils through ligand exchange by 1 : 1 clay minerals, Fe and Al oxides and hydroxides, and is thus precipitated as Fe, Al, and Ca phosphates **(Shen *et al.,* *2011***, **Almeida *et al.,* 2018**).

Weather has an impact on crop development at various phenological stages, which explains why yields vary from year to year and location to location. The response of crops to weather has been measured using a variety of statistical approaches, including multiple regressions, principal component analysis **(Jain *et al*., 1984),** Markov chain **analysis (Ramasubramanian *et al*., 1999),** and agro-meteorological models **(Walker, 1989).** In India, agricultural yields were predicted using multiple regression models **(Appa Rao, 1983).** To assess yield patterns and forecast yields in various circumstances, time series analysis is utilised.

Materials and methods

The experiment was conducted during the S*ummer* season 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25^{o} 39’ 42’’N latitude, 81^{o} 67’ 56” E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj - Rewa road about 12 km from the city. The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.51%), available N (78.9 kg/ha), available P (32.88 kg/ha), available K (385.10 kg/ha). Nutrient sources was nano phospo to fulfil the requirement of Phosphorus respectively. The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice. The treatments were 1)K1812 + nano phosphorus at 2ml/lit, 2) K1812 + nano phosphorus at 4ml/lit, 3)K1812+ nano phosphorus at 6 ml/lit, 4)K6+ nano phosphorus at 2 ml/lit, 5)K6+ nano phosphorus at 4 ml/lit, 6)K6+ nano phosphorus at 6 ml/lit, 7)K9+ nano phosphorus at 2 ml/lit, 8)K9+ nano phosphorus at 4 ml/lit and 9)K9+ nano phosphorus at 6 ml/lit.

The growth parameters of the plants were recorded at frequent intervals from sowing up until 100 DAT and finally, the yield parameters were recorded after harvest. Analysis of Variance (ANOVA) was used statistically to examine these variables using the Randomized Block design. The Pearson's correlation between the measured yield and the individual weather parameters as well as the combination of weather parameters was calculated using SPSS (Statistical Product and Service Solutions). The correlation coefficient has been obtained from the sum of weather parameters and the sum product of various weather parameters. The dependant variable (yield) and the independent variables (time, sum, and sum products for various meteorological conditions) were regressed many times. The regression formula was used to create the regression equation.

Result and Discussion

Plant height (cm)

The highest plant height was recorded with Treatment T3 (k1812+ nano phosphorus at 6 ml/lit) i.e., 61.39 cm. However, Treatment T6 (k6 + nano phosphorus at 6 ml/lit) i.e., 60.28 cm is statistically at par with Treatment T3. Whereas minimum plant height was seen in Treatment T7 with k9 + nano phosphorus at 2 ml/lit.

It seems that the role of Phosphorus nano-fertilizer at the vegetative stage of peanut was a synergistic effect on the recommended conventional fertilizer for better absorption of nutrients and thereby resulting in optimal growth (**Liu and Lal, 2014).**

Plant dry weight

The highest plant Dry weight was recorded with Treatment T3 (k1812+ nano phosphorus at 6 ml/lit) i.e., 42.34 g/plant. However, Treatment T6 (k6 + nano phosphorus at 6 ml/lit) i.e., 41.44 g/plant is statistically at par with Treatment T3. Whereas minimum plant Dry weight was seen in Treatment T7 with k9 + nano phosphorus at 2 ml/lit.

The application of biophos and nanophos showed on initial burst and subsequently slow release even up to 60th day as compared to the commercial fertilizers which released phosphorus heavily in the initial stages followed by low and non-uniform quantity until around 30 days. There is a possibility that the bio and nano phosphatic fertilizers synchronised release of phosphorus with uptake by crop thereby preventing losses into soil **(De Roseet *et al.*, 2010)**.

Crop growth rate (g/m^2/day) and Relative growth rate (g/g/day)

The significantly maximum crop growth rat e was recorded with Treatment T2 (k1812+ nano phosphorus at 4 ml/lit) i.e., 15.68 g/m^2/day. However, T1 (k1812 + nano phosphorus at 2 ml/lit) i.e., 15.23 g/m^2/day, T3 (k1812 + nano phosphorus at 6 ml/lit) i.e., 15.47 g/m^2/day and Treatment T6 (k6+ nano phosphorus at 6 ml/lit) i.e., 15.26 g/m^2/day is found to be statistically at par with Treatment T2. Whereas minimum crop growth rat e was seen in Treatment T7 (k9+ nano phosphorus at 2 ml/lit).

The significantly maximum Relative growth rat e was recorded with Treatment T1 (k1812+ nano phosphorus at 2 ml/lit) i.e., 0.0153 g/g/day. However, T4 (k6 + nano phosphorus at 2 ml/lit) i.e., 0.0151 g/g/day is found to be statistically at par with Treatment T4. Whereas minimum Relative growth rate was seen in Treatment T3 (k1812 + nano phosphorus at 6 ml/lit).

Yield parameters

The highest number of Pods per plant differed significantly. The highest number of pods per plant was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e.,32.87. Where as minimum number of pods per plant are seen in Treatment T7 (k9 + nano phosphorus at 2 ml/lit).

The highest number of kernel per pod differed Non-significantly. The highest number of kernel per pod was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e., 2.20. Whereas minimum number of kernel per pod are seen in Treatment T8 (k9+ nano phosphorus at 4 ml/lit).

The highest seed index differed significantly. The highest seed index was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e., 42.09 g. Whereas minimum seed index is seen in Treatment T7 (k9 + nano phosphorus at 2 ml/lit).

Higher increase in number of pods per plant, number of kernels per pod and hundred pod weight as recorded under 60 and 40 kg P2O5ha-1increase in yield at tributes might be due to stimulating effect of phosphorus on plant metabolic processes as phosphorus is a major constituent of cell nucleus and growing root tips which help in cell division and root along at ion **(Brady, 1983)**.

Yield (t/ha)

The highest pod yield differed significantly. The highest pod yield was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e.,2.98 t/ha. Whereas minimum pod yield is seen in Treatment T7 (K1812 + nano phosphorus at 2 ml/lit).

The highest haulm yield differed significantly. The highest haulm yield was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e., 4.46 t/ha. Whereas minimum straw yield is seen in Treatment T7 (K1812 + nano phosphorus at 2 ml/lit).

The highest harvest index differed significantly. The highest harvest index was recorded in Treatment T3 (k1812+ nano phosphorus at 6 ml/lit). i.e., 40.07%. Whereas minimum harvest index is seen in Treatment T2 (k1812+ nano phosphorus at 4 ml/lit).

Maximum yield was obtained with 60 kg P2O5ha-1this might be due to better below groundnut plant growth. P being an essential constituent of nucleic acids, phytin, phospholipids and enzymes is responsible for root development and seed format ion **(Naphade and Waphade, 1991)**.

Yield validation using SPSS model

The multi-regression analysis using SPSS has been employed for the estimation of rice yield. The regression for SPSS model is

Y = 1.675 + (0.0000495 x Z231 of prediction year) + (0.0367 x time)

Here, Z231 is the sum product of minimum temperature.

The yield obtained in treatment T3 with (k1812+ nano phosphorus at 6 ml/lit) (2.98 t/ha) showed 42.28% increase over the predicted yield through SPSS model (1.72 t/ha].

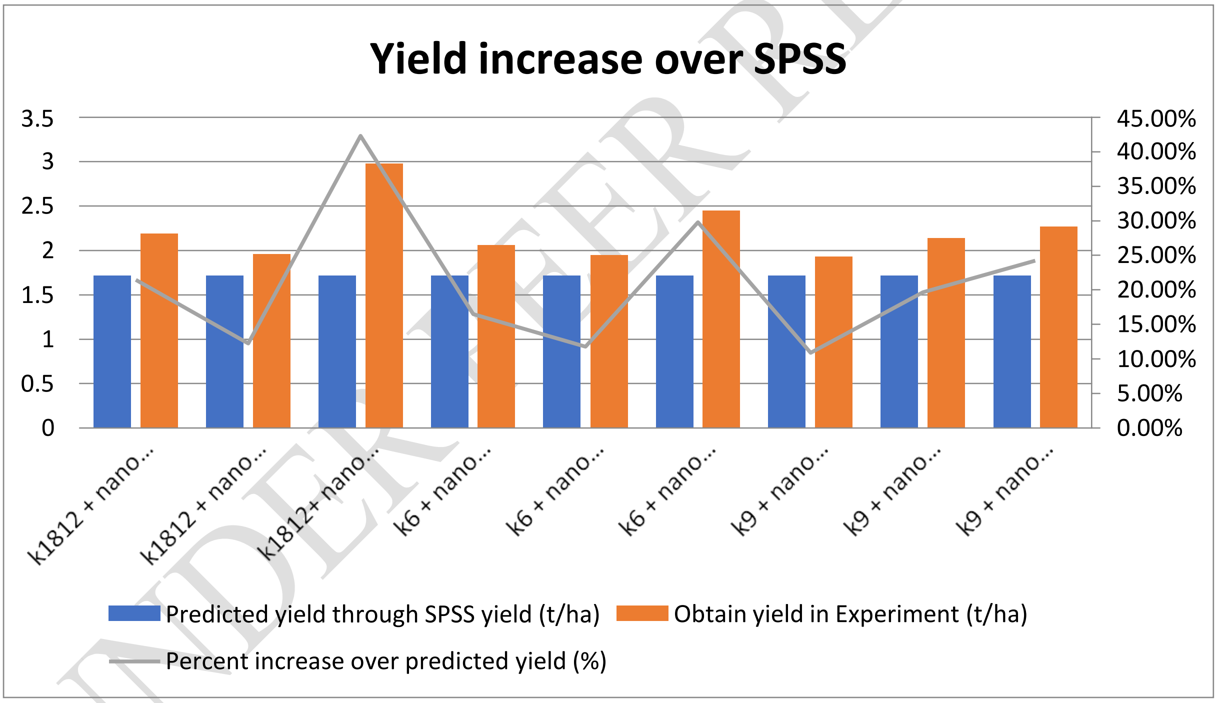

Fig 1. Percentage of yield increase over SPSS model

Table 1. Effect of nano phosphorous on growth attributes of groundnut varieties

Sl. no	Treatments	100 DAT		80-100 DAT	
		Plant height (cm)	**Dry weight (g/hill)**	**Crop growth rate (g/m^2/day)**	**Relative growth rate (g/g/day)**
1.	k1812 + nano phosphorus at 2ml/lit	56.30	37.52	15.23	0.0153
2.	k1812 + nano phosphorus at 4ml/lit	58.45	39.67	15.68	0.0148
3.	k1812+ nano phosphorus at 6 ml/lit	61.39	42.34	15.47	0.0135
4.	k6 + nano phosphorus at 2 ml/lit	55.73	36.84	14.73	0.0151
5.	k6 + nano phosphorus at 4 ml/lit	57.32	37.37	14.15	0.0141
6.	k6 + nano phosphorus at 6 ml/lit	60.28	41.44	15.26	0.0136
7.	k9 + nano phosphorus at 2 ml/lit	55.53	35.80	13.71	0.0143
8.	k9 + nano phosphorus at 4 ml/lit	57.16	37.58	14.57	0.0145
9.	k9 + nano phosphorus at 6 ml/lit	59.48	40.36	15.06	0.0138
	F test	S	S	S	S
	SEm(+)	0.38	0.36	0.16	0.0001
	CD(P=0.05)	1.13	1.08	0.49	0.0003

Table 2. Effect of nano phosphorous on yield attributes of groundnut varieties

Sl. no	Treatments	**Number of Pods/plant**	**Number of Kernels/pod**	**Seed index (g)**	**Pod yield (t/ha)**	**Haulm yield (t/ha)**	**Harvest index (%)**
1.	k1812 + nano phosphorus at 2ml/lit	20.93	2.00	37.40	2.19	3.83	36.39
2.	k1812 + nano phosphorus at 4ml/lit	23.73	2.00	38.80	1.96	3.91	33.40
3.	k1812+ nano phosphorus at 6 ml/lit	32.87	2.20	42.09	2.98	4.46	40.07
4.	k6 + nano phosphorus at 2 ml/lit	19.27	1.93	37.22	2.06	3.74	35.54
5.	k6 + nano phosphorus at 4 ml/lit	21.87	1.87	38.78	1.95	3.85	33.61
6.	k6 + nano phosphorus at 6 ml/lit	31.20	2.13	41.32	2.45	4.28	36.41
7.	k9 + nano phosphorus at 2 ml/lit	18.67	1.87	36.51	1.93	3.51	35.45
8.	k9 + nano phosphorus at 4 ml/lit	18.73	1.73	38.20	2.14	3.84	35.82
9.	k9 + nano phosphorus at 6 ml/lit	28.47	1.93	40.20	2.27	4.06	35.83
	F test	S	NS	S	S	S	S
	SEm(+)	0.12	0.09	0.06	0.01	0.02	0.13
	CD(P=0.05)	0.37	----	0.17	0.03	0.05	0.40

Conclusion

From the results, It can be concluded that better production and economics return among 3 varieties of Groundnut was observed in K-1812 by the applicat ion of Nano phosphorus at the rat e of 6 ml/lit. Since the findings based on one season, further trails are needed to confirm the result.

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