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Impact of Planting Dates on NPK Content in Soybean Plants and Seeds across Different Cultivars

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Soybean *Glycine max* (*L.).* growth, development, and production are negatively impacted by delayed planting dates and poor environmental circumstances. The nitrogen accumulation, phosphorus accumulation, potassium accumulation at harvest and nitrogen content, phosphorus content, potassium content in seed impacted by changes in photoperiod, temperature, and precipitation with delayed planting. Extremely high temperatures and drought stress are examples of environmental variables that negatively impact plant development and productivity and are frequently linked to delayed planting.

Keywords: Nitrogen; phosphorus; potassium; sowing dates; soybean.

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1. INTRODUCTION

Soybean is the second significant oilseed crop grown in various pieces of India after groundnut. Major soybean producing countries in the world are USA, Brazil, Argentina, China and India. Madhya Pradesh is one of the significant soybean producing Indian states. The crop is mainly grown during the kharif season under rain-fed condition. The inter-annual variation in area and production of soybean crop is mainly depends on the rainfall pattern. During the good monsoon year farmers are allocating more area under the crop, whereas it is reduced during the poor monsoon year and this affects overall production of soybean.

Legumes provide a protein-rich source of food which is essential part in the diets of people inhabiting in the tropics. Legumes are productive and protective agricultural food products and also contribute to maintenance and restoration of soil fertility by biologically fixing a large proportion of atmospheric nitrogen (N) [1,2]. All over the world, particularly in the developing countries it is increasing by being realized that we must strive for a sustainable agriculture one which can feed their burgeoning populations not at the environmental cost exacted by present day intensive farming practices. But this is not the case for nitrogen, one of the nutrients required in the largest quantities for plant growth, and one which is commonly limiting for agricultural production. N can be directly captured 'fixed' from the atmosphere [3,4-6] by legumes. These crops have therefore been long recognized as important components of crop rotations and intercrops in the semi-arid tropical (SAT) farming systems. Environmental conditions associated with late sowing affect crop features related to the capture of radiation and portioning of crop resources. These includes less vegetative growth [7], shorter stems [8]; lower reproductive nodes [7], and shortening of the reproductive phases [9,10,11]. Sowing dates influence soybean growth stages, due to variation in photoperiod [12,13], air temperature [14], and rainfall distribution and amount during the crop cycle (Hu and Wiatrak, 2010). Meotti et al. [15] observed that 77% of soybean yield variability was associated with climate conditions induced by the sowing dates In order to increase the profitability of soybean production, sowing at different dates is a good strategy.

2. MATERIALS AND METHODS

2.1 Field Experiment

A field experiment was conducted at the farm of Lovely professional university, Phagwara, India in 2022 -2023 to examine the effect of planting dates on NPK in soybean plants and seeds across different cultivars. Variety i.e. SL 958, SL1028, PL1092 were tested under various doses of RDF at different sowing dates i.e. 12june ,27june ,12 july. Yield, growth and quality parameters were recorded during the research work. The experiment had a split plot design with nine treatments (T1: D1+V1, T2: D1+V2, T3:D1+V3, T4:D2+V2, T5: D2+V2, T6: D2+V3, T7: D3+V1, T8: D3+V2, T9: D3+V3) D1: First fortnight of june, D2: Second fortnight of June, D3: First fortnight of July and V1: SL958, V2: SL1028, V3: PL1098 with three replication.

2.2 Analysis of Nitrogen Availability in Plant

Nitrogen content in plant was obtained by adopting the procedure of kjeldahl method as reported by Kirk, P.L [16]. Transfer 1g of prepared plant material wrapped in a piece of filter paper, to a 300 kjeldhal's digestion flask. Add to it 10g of catalyst mixture and 25-30 ml of concentrated sulphuric acid. Mix the contents of the flask by swirling with care not to through the samples on the side. Start digesting the contents of the flask on digestion heater for 20-30 min until frothing stops. Continue heating until the organic matter is destroyed and the solution is light yellow or grey colour. Cool and make the volume 100ml with distilled water. Pipette out 10ml of 0.02N sulphuric acid in a 150ml conical flask, add 2-3 drops of methyl red indicator. Take 5ml of aliquot in distillation flask and connect it to the mouth of distillation flask. Now pour 25ml of 45%NaOH in distillation flask through the funnel attached to the distillation apparatus. Collect about 30ml the distillate. Titrate the excess of .02N sulphuric acid in a conical flask against 0.02N NaOH. The end point is change in colour from pink to yellow.

2.3 Analysis of Phosphorous Availability in Plant

Phosphorous content in plant was obtained by adopting the procedure of colorimetric method as reported by Cavell, A. J [17]. Take 5ml of plant digest in 25ml volumetric flask. Add 1-2 drops of 2-4 dinitrophenol indicator and 4N sodium bicarbonate solution drop wise till yellow color appears. Now add 6N HCL drops wise till yellow colour disappears. Add 2.0ml of 6N HCL in excess to get required pH of 4.8. At this stage add 5ml vanadate moly date reagent and make up and make up volume upto 25ml. The colour develops in several minutes and is stable for 2 months at high P concentration, but at P concentration of 5 ppm it is stable for only 2 weeks. Prepare a blank in the similar way. Read the intensity of yellow colour formed on a spectronic 20 photoelectric calorimeter at a wavelength of and make up the volume upto 25ml. The color develops in several minutes and is stable for 2 months at high P concentration, but at P concentration of 5 pm it is stable for only 2 weeks. Prepare a blank in the similar way. Read the intensity of yellow colour formed on a spectronic 20 photoelectric calorimeter at a wavelength of 470nm.

2.4 Analysis of Potassium Availability in plant

Available potassium in plant was determined with flame photometer and analyzing the filtered extract on an atomic absorption spectrometer set on emission mode at 766.5nm. as reported by A.S. Mailappa in the Book Experimental Soil Fertility and Biology.

3. RESULTS AND DISCUSSION

3.1 Nitrogen Accumulation in Plant at Harvest (g)

The data pertaining to nitrogen accumulation in plant at harvest was given in the Table 1. The different dates of sowing showed the significant effect on nitrogen in plant at harvest of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest nitrogen in plant at harvest (1.10 g) higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum nitrogen in plant at harvest (0.98 g) was recorded 12th July (D3) sowing. The varieties also differed significantly nitrogen in plant at harvest. Amongst the varieties, SL958 (V1) attained maximum nitrogen in plant at harvest (1.04 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum nitrogen in plant at harvest (1.00 g) was attained from PL1092 (V3). Fabre, F. & Planchon, C. [18] noticed that nitrogen nutrition, yield and protein content in soybean.

3.2 Phosphorus Accumulation in Plant at Harvest (g)

The data pertaining to phosphorus accumulation in plant at harvest was given in the Table 2. The different dates of sowing showed the significant effect on phosphorus in plant at harvest of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest phosphorus in plant at harvest (0.89 g), being significantly higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum phosphorus in plant at harvest (0.85 g) was recorded on 12th July (D3) sowing. The varieties also differed significantly in phosphorus in plant at harvest. Amongst the varieties, SL958 (V1) attained maximum phosphorus in plant at harvest (0.88 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum phosphorus in plant at harvest (0.86 g) was attained from PL1092 (V3).

Singh et al. [19] also reported that response of soybean (*Glycine max* (L.) to sources and levels of phosphorus.

3.3 Potassium Accumulation in Plant at Harvest (g)

The data pertaining to potassium accumulation in plant at harvest have been given in the Table 3. The different dates of sowing showed the significant effect on potassium in plant at harvest of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest potassium in plant at harvest (1.41 g), significantly higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum potassium in plant at harvest (1.29 g) was recorded on 12th July (D3) sowing. The varieties also differed significantly in potassium in plant at harvest. Amongst the varieties, SL958 (V1) attained maximum potassium in plant at harvest (1.37 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum potassium in plant at harvest (1.31 g) was attained from PL1092 (V3).

Borkert et al. [20] observed that calibration of potassium in soybean.

3.4 Nitrogen Content in Seed (g)

The data pertaining to nitrogen content in seed was given in the Table 4. The different dates of sowing showed the significant effect on nitrogen content in seed of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest nitrogen content in seed (5.28 g), being significantly higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum nitrogen content in seed (5.03 g) was recorded on 12th July (D3) sowing. The varieties also differed significantly in nitrogen content in seed. Amongst the varieties, SL958 (V1) attained greatest nitrogen content in seed (5.27 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum nitrogen content in seed (5.05 g) was attained from PL1092 (V3).

Ohyama et al. [21] stated that soybean seed production and nitrogen nutrition.

3.5 Phosphorus Content in Seed (g)

The data pertaining to phosphorous content in seed was given in the Table 5. The different dates of sowing showed the significant effect on phosphorus content in seed of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest phosphorus content in seed (0.70 g), being significantly higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum phosphorus content in seed (0.64 g) was recorded on 12th July (D3) sowing. The varieties also differed significantly in phosphorus content in seed. Amongst the varieties, SL958 (V1) attained maximum phosphorus content in seed (0.68 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum phosphorus content in seed (0.66 g) was attained from PL1092 (V3).

Kumaga and Ofori [22] observed that the many factors that can subsidize to the success of soybean, phosphorus has significant implications on growth and yield attributes.

Table 1. Effect of Planting dates on nitrogen in plant at harvest (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	SL1028	PL1092	
First fortnight of June (12 June)	1.153	1.100	1.050	1.101
Second fortnight of June (27 June)	1.003	1.010	0.980	0.998
First fortnight of July (12 july)	0.987	0.977	0.977	0.980
Mean	1.048	1.029	1.002	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	0.027	0.009	0.007
Varieties	0.033	0.015	0.011
Between different varieties at same sowing date	N/A	0.026	0.011
Between different sowing date at same or different varieties.	N/A	0.023	0.016

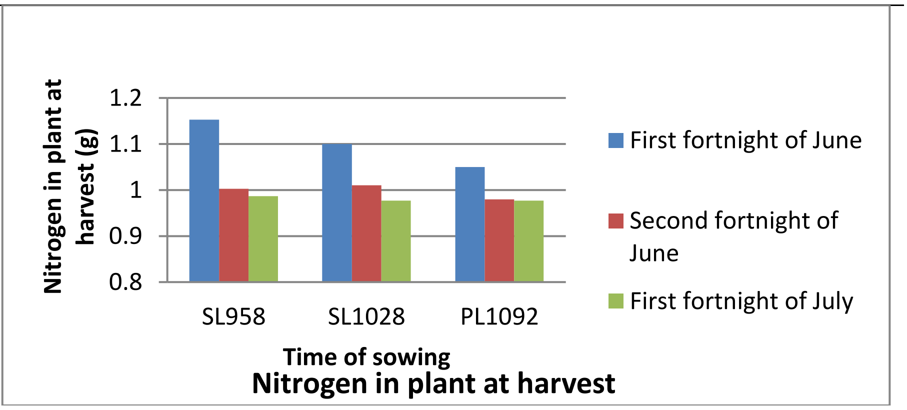

Fig. 1. Effect of Planting dates on nitrogen in plant at harvest (g) of different cultivars of soybean

Table 2. Effect of Planting dates on phosphorus in plant at harvest (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	**SL1028**	**PL1092**	
First fortnight of June (12 June)	0.913	0.887	0.877	0.892
Second fortnight of June (27 June)	0.873	0.877	0.870	0.873
First fortnight of July (12 july)	0.867	0.850	0.843	0.853
Mean	0.884	0.871	0.863	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	0.023	0.008	0.006
Varieties	0.012	0.005	0.004
Between different varieties at same sowing date	N/A	0.009	0.010
Between different sowing date at same or different varieties.	N/A	0.011	0.008

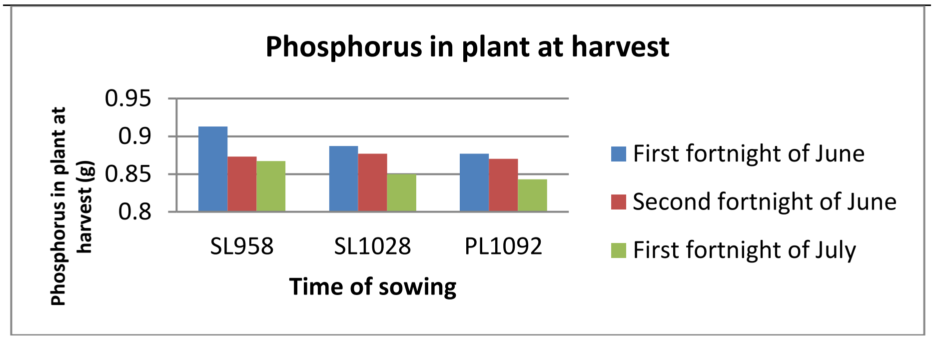

Fig. 2. Effect of Planting dates on phosphorus in plant at harvest (g) of different cultivars of soybean

Table 3. Effect of Planting dates on potassium in plant at harvest (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	**SL1028**	**PL1092**	
First fortnight of June (12 June)	1.440	1.403	1.390	1.411
Second fortnight of June (27 June)	1.350	1.343	1.293	1.329
First fortnight of July (12 july)	1.337	1.287	1.260	1.294
Mean	1.376	1.344	1.314	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	0.025	0.009	0.006
Varieties	0.020	0.009	0.006
Between different varieties at same sowing date	N/A	0.016	0.011
Between different sowing date at same or different varieties.	N/A	0.016	0.011

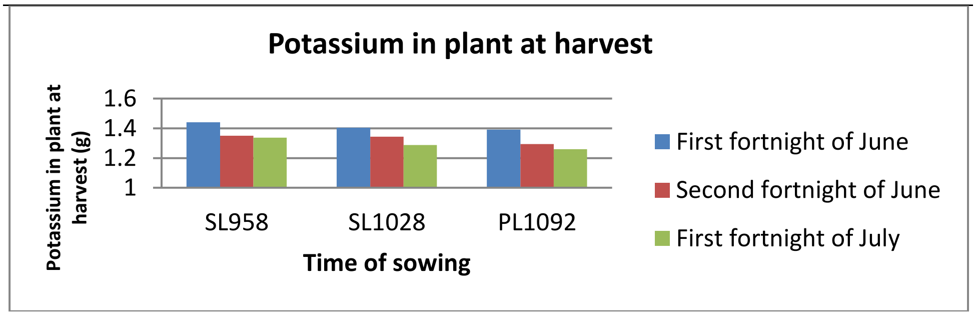

Fig. 3. Effect of Planting dates on potassium in plant at harvest (g) of different cultivars of soybean

Table 4. Effect of Planting dates on nitrogen content in seed (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	SL1028	PL1092	
First fortnight of June (12 June)	5.350	5.280	5.213	5.281
Second fortnight of June (27 June)	5.273	5.297	5.057	5.209
First fortnight of July (12 july)	5.207	5.020	4.883	5.037
Mean	5.277	5.199	5.051	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	0.068	0.024	0.017
Varieties	0.075	0.034	0.024
Between different varieties at same sowing dates	N/A	0.059	0.029
Between different sowing date at same or different varieties.	N/A	0.054	0.038

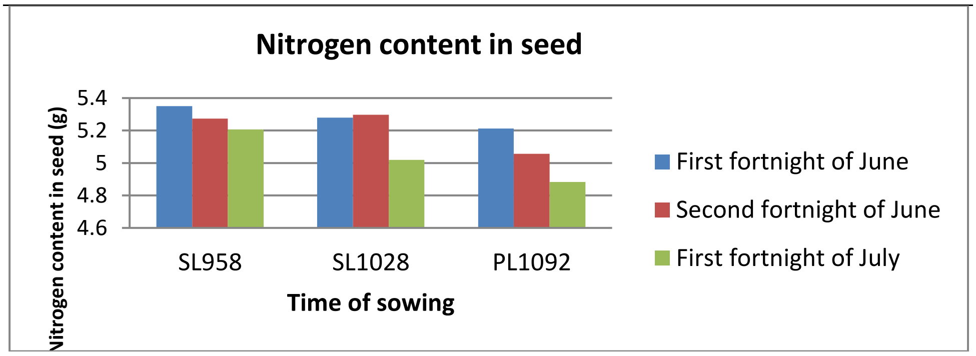

Fig. 4. Effect of Planting dates on nitrogen content in seed (g) of different cultivars of soybean

Table 5. Effect of planting dates on phosphorus content in seed (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	SL1028	PL1092	
First fortnight of June (12 June)	0.707	0.707	0.703	0.706
Second fortnight of June (27 June)	0.683	0.687	0.667	0.679
First fortnight of July (12 july)	0.657	0.647	0.627	0.643
Mean	0.682	0.670	0.666	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	0.019	0.007	0.005
Varieties	0.009	0.004	0.003
Between different varieties at same sowing dates	N/A	0.007	0.008
Between different sowing date at same or different varieties	N/A	0.009	0.006

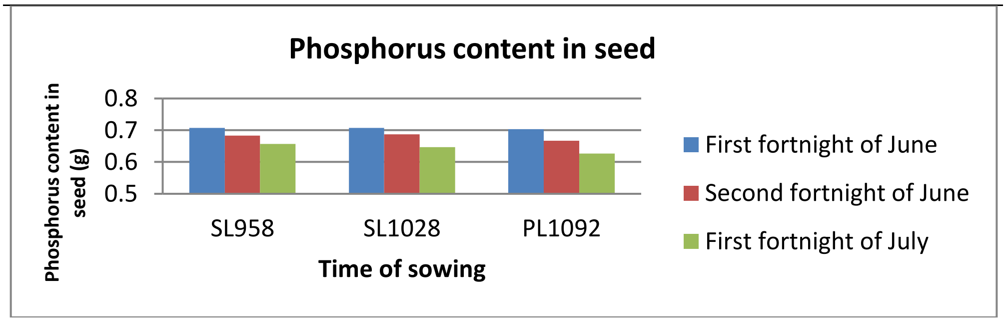

Fig. 5. Effect of Planting dates on phosphorus content in seed (g) of different cultivars of soybean

Table 6. Effect of planting dates on potassium content in seed (g) of different cultivars of soybean

Sowing dates	Varieties			Mean
	SL958	SL1028	PL1092	
First fortnight of June (12 June)	1.773	1.763	1.723	1.753
Second fortnight of June (27 June)	1.693	1.713	1.690	1.699
First fortnight of July (12 july)	1.680	1.670	1.663	1.671
Mean	1.716	1.706	1.692	

Factors	C.D.	SE(d)	SE(m)
Sowing dates	N/A	15.620	11.045
Varieties	N/A	15.630	11.052
Between different varieties at same sowing dates	N/A	27.072	19.131
Between different sowing date at same or different varieties	N/A	27.066	19.139

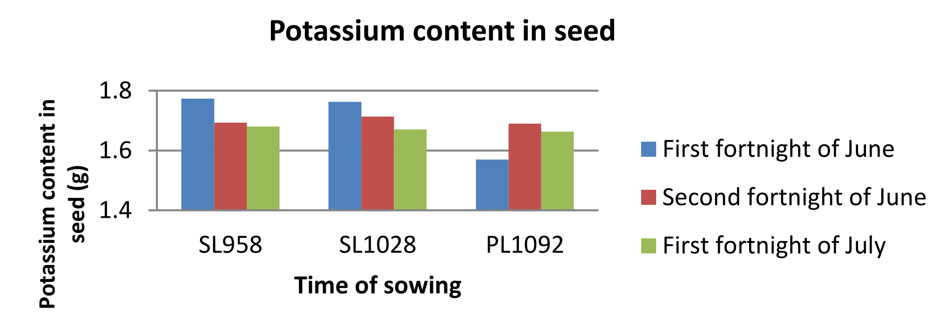

Fig. 6. Effect of Planting dates on potassium content in seed (g) of different cultivars of soybean

3.6 Potassium Content in Seed (g)

The data pertaining to potassium content in was given in the Table 6. The different dates of sowing showed the significant effect on potassium content in seed of different soybean varieties. Accordingly, out of different sowing dates the earliest 12th June (D1) recorded the highest potassium content in seed (1.75 g), being significantly higher than 27th June (D2) and 12th July (D3) sowing dates. The minimum potassium content in seed (1.67 g) was recorded on 12th July (D3) sowing. The varieties also differed significantly in potassium content in seed. Amongst the varieties, SL958 (V1) attained maximum potassium content in seed (1.71 g), which was significantly higher than SL1028 (V_2) and PL1092 (V_3). The minimum potassium content in seed (1.69 g) was attained from PL1092 (V3).

Borges, R., & Mallarino, A. P. [23] reported that grain yield, early growth, and nutrient uptake of no-till soybean as affected by phosphorus and potassium placement.

4. CONCLUSION

From the analysis of research done, it has been concluded that 12th June (D1) resulted in increasing nitrogen, phosphorus, potassium in plant at harvest, and nitrogen, phosphorus, potassium content in seed, Amongst the varieties, SL958 (V1) was gave significant results than other varieties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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