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Effect of method of sowing and seed rate on soil physico-chemical properties and nutrient content of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted at the Instructional Cum Research Farm of the Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chhattisgarh during winter seasons of 2015-16 and 2016-17 to study the effect of method of sowing and seed rate on soil physico-chemical properties of wheat (*Triticum aestivum* L.). The treatment combination of 3 methods of sowing *viz*. Broadcast methods of sowing (M_1), Line sowing (M_2) and Criss cross methods of sowing (M_3) as main plot and 5 seed rates based on 100 kg ha^{-1} (SR_1), 125 kg ha^{-1} (SR_2), 150 kg ha^{-1} (SR_3), 175 kg ha^{-1}(SR_4) and 200 kg ha^{-1} (SR_5) sub-plot was laid out in split plot design with three replications. Results revealed that NPK content in grain and straw was obtained non-significant under methods of sowing and seed rates. However, maximum NPK content was observed in broadcast methods of sowing and seed rates 100 kg per ha^{-1}. Different methods of sowing and seed rates were also found non-significant in available NPK in soil after harvest.

Keywords: Methods of sowing, seed rates and physico-chemical properties of soil, grain and straw

Introduction
Wheat (*Triticum aestivum* L.) is a major cereal crop of the world occupying an area of 225.62 million hectares with a production of 685.6 Million tonnes and productivity of 3039 kg ha^{-1}. India is second largest producer of wheat in the world after China with about 12 percent share in total world production. In India, wheat is second most important food crop, next to rice, with an area of 30.42 Million hectares with a production of 92.29 Million tonnes (Anonymous, 2016). The average productivity is 2.96 tonnes ha^{-1}. In Chhattisgarh, wheat is cultivated on area of 1.108 Lakh hectares with a production of 1.268 Lakh M tonnes. The average productivity of wheat in Indian is lower to many wheat growing regions of the world. On the other hand the mean yield of wheat in Chhattisgarh is even less than the half (1144 kg ha^{-1}) of the national yield. The huge yield gap between the average productivity and the potential of the agricultural lands suggests that the prospect for increasing production through improved crop and soil management, particularly increased use of N fertilizers, optimum seed rate and appropriate methods of sowing is very high. The grain yield is a function of interaction between genetic and environmental factors like soil type, sowing time and method, seed rate, fertilizers and time of irrigation. Among these factors, methods of sowing and appropriate seed rate play a vital role in getting higher grain yield of wheat. The method of sowing is significant as it determines the proper crop stand establishment and the production of individual plant depends on balancing plant to plant competition. In India especially in Chhattisgarh, wheat is planted through broadcasting on a large area after rice harvesting. Broadcasting not only requires higher seed rate but also results in lower plant population, whereas drill sowing method is recommended because of its uniform seed distribution and sowing at desired depth, which usually results in higher germination and uniform stand. A key factor in the highest wheat production is the understanding of an early crop establishment. Beside other agronomic factors seed rate and sowing method are major factors which determines the crop vigor and ultimate yield (Korres and Froud, 2002). Wheat sown by drilling method significantly increased the plant vigor, tillering, number of spikes plant^{-1}, number of grains spike^{-1} and yield (Soomro *et al*., 2009) [3]. Bidirectional sowing showed higher photosynthetically active radiation interception (PARI) and yielding ability at recommended inputs. The beneficial effect of line and cross sowing has been reported by several researchers. Manipulation of agronomic practices such as planting pattern/geometry and seed rate are considered to be foremost step to achieve proper distribution of plants over cultivated area, thereby better utilization of above and below ground natural resources towards increasing yield (Jat and Singhi, 2004) [4].

Plant density is also a major factor determining the ability of the crop to capture resources and generate yield. It can be developed by using a suitable seeding rate. Normal seed rate results in lower yield than higher seed rate under late sown conditions. Yield in wheat is dependent mainly on the number of spikes per unit area and average seed yield per spike, where the number of spikes per unit area can well be compensated by using higher seed rate as practiced in several other wheat growing parts of the world. Plant density is a major factor determining the ability of the crop to capture resources and generate yield. It can be developed by using a suitable seeding rate. Growth and yield of wheat are affected by environmental conditions and can be regulated by sowing time and seeding rate (Ozturk *et al*., 2006) [5]. Depending on the environmental conditions, soil, sowing time and genotypes, seeding rate can have a great impact on wheat tillering and grain yield of wheat. As the plant density increases, the competition for resources especially for nitrogen also increases that badly affect the ultimate yield.

Materials and Methods

A field experiment was conducted at the Instructional Cum Research Farm of the Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (21°4' N latitude, 81^{0}39' E longitude and located at altitude of 298 meter above mean sea level), Chhattisgarh during winter seasons of 2015-16 and 2016-17 to study the effect of method of sowing and seed rate on soil physico-chemical properties of wheat (*Triticum aestivum* L.). The soil of the experimental plot was vertisols in nature having pH (7.13), EC (0.17 dSm^{-1}), low in OC (0.43%) and available NPK were low (216.86 kg/ha), medium (14.78 kg/ha), low (267.15 kg/ha). Three levels of methods of sowing based on Broad Casting (MS_1), Line Sowing (MS_2) and Criss cross Sowing (SR_3) as main plot and 5 Seed rates *viz*. 100 kg ha^{-1} (SR_1), 125 kg ha^{-1} (SR_2), 150 kg ha^{-1} (SR_3), 175 kg ha^{-1} (SR_4) and 200 kg ha^{-1} (SR_5) in sub-plot was laid out in split plot design with three replications. The gross plot size was 5.06 m x 3.96 m. The methods of sowing and seed rates were varying according to treatments Crop was sown on 25 November, 2015, 15 November 2016 and harvested on 15 march 2016 and 5 march 2017. The pH of the soil was measured with the help of a systronic pH meter maintaining the soil: water ratio at 1: 2 as described by (Jackson 1973) [6]. The organic carbon content of the soil was estimated by (Walkley and Black 1934) [7] method as described by (Jackson 1973) [6]. Available N was determined by the distillate was titrated against N/50 H_2SO_4 following the method prescribed by (Subbiah and Asija 1956) [8]. Available P was extracted by Olsen's method (Jackson, 1973) [6]. The soil was extracted with 0.5 M $NaHCO_3$ (pH 8.5) maintaining the soil and extractant ratio of 1: 20. Available K 5 g soil was shaken with 25 ml normal ammonium acetate (pH 7) for 5 minutes and filtered. Potassium (K_2O) was estimated in the extract with the help of flame photometer after necessary setting and calibration of the instrument (Jackson, 1973) [6]. Di-acid extract was prepared as per the method described by Jackson (1967) [6]. The plant samples were digested with di-acid mixture of Conc. nitric acid (HNO_3) and perchloric acid ($HClO_4$) in the ratio of 9:4. This extract was used to determine the total P and K from plant samples. Total nitrogen from plant samples was estimated by using Micro Kjeldahl's method as described by Piper (1966) [10]. For determined the P content in plant by using vanado-phosphate molybdate yellow colour method from di-acid extract as described by Kitson and Mellon (1944) [11]. For determined K content in plant by using flame photometer with di-acid extract as described by Piper (1966) [10].

Results and Discussion

Nitrogen, phosphorus and potassium content (%)

The data on nitrogen, Phosphorus and potassium content in grain and straw of wheat as influenced by different treatments are presented in Table 1 & 2. Analysis of variance showed that both methods of sowing and seed rates did not affect the nitrogen contents in grain and straw significantly during both the years as well as across the years. Results revealed that the maximum pooled nitrogen, phosphorus and potassium contents of 1.982, 0.466 and 0.603% in grain and 0.580, 0.176 and 0.937% in straw respectively was recovered by the crop under broad cast sowing (MS_1) compared to other two methods of sowing during respective years. This may be due to that suitable sowing method helped in seed placement at proper depth and uniform seed distribution, creating better seed to soil contact, faster plant emergence and more homogenous plant stand. These results are in accordance with the findings of Singh *et al*. 2015 [12].

Among seed rates did not caused significant variations in the N, P and K contents in grain and straw during both years. However, traditional seeding rate of 100 kg ha^{-1} resulted in greater pooled N, P and K contents of, 1.985, 0.479 and 0.610% in grain and 0.589, 0.176 and 0.947% in straw during 2015-16 and 2016-17, respectively. Whereas, the minimum amounts of N contents in both grain and straw was observed in the produce obtained from the plots seeded with 150 kg ha^{-1} (SR_3) seed rate. This could be due to the less competition between plants for nutrient therefore maximum N content was observed in seed rate 100 kg ha^{-1}. Similar results have been obtained by Iqbal *et al*. (2010) [13] and Ram *et al*. (2013) [14].

Available nitrogen, phosphorus and potassium content in soil (kg ha^{-1})

The available nitrogen, phosphorus and potassium in soil after harvest of wheat as influenced by different treatments is presented in Table 3. The pooled available N in soil varied from 186.9 to 195.9 kg ha^{-1} indicating that the soil still remained low in available N content after harvest of the wheat crop. The maximum pooled amount of available N, P and K *viz*., 195.3, 20.82 and 307.22 kg ha^{-1} in soil after the harvest of wheat was estimated in the plots adopted broadcast method of sowing during 2015-16 and 2016-17, respectively which was significantly higher over the plots sown with other methods of sowing which might be due to the less uptake of nitrogen in plant. Thus, it can be inferred that available N was depleted significantly by the crop sown with criss-cross methods when compared to their initial N status during both the years. Proper sowing method encourages nutrient availability, proper light penetration for photosynthesis, good soil environment for soil nutrients uptake and water use efficiency which enhances crop vigour and yield. The present results are in agreement with the findings of Abbas *et al*. (2009) [5] and Khattak *et al*. (2012) [16].

Different level of seed rates also affects the available N, P and K status after harvest of the crop during both the years. Wheat crop sown using a traditional seed rate of 100 kg ha^{-1} (SR_1) resulted in maximum pooled amount of available N, P and K *viz*., 197.2, 21.29 and 310.01 kg ha^{-1} after harvest during 2015-16 and 2016-17 respectively which tended to be significantly higher overall succeeding seeding rates during both the seasons of investigation. Crop sown with highest seeding rate of 200 kg ha^{-1} exhausted the available N, P and K

after harvest of the crop of respective seasons which was significantly lower than those of upper three seeding rates as well as the initial available N status of the soil during both the years. The higher level of seed rate decreased the grain weight earhead^{-1} owing to the poor photosynthesis, which was largely accounted by the smaller grains. These results are in line with the findings of Hussain *et al*. (2006) [17] and Laghari *et al*. (2011) [18].

Table 1: Nitrogen content (%) and uptake (kg ha^{-1}) by wheat as influenced by methods of sowing and seed rates during year 2015-16 and 2016-17

Treatments	Nitrogen Content (%)						Phosphorus Content (%)					
	Grain			Straw			Grain			Straw		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Methods of Sowing												
MS_1	1.980	1.985	1.982	0.574	0.587	0.580	0.466	0.467	0.466	0.168	0.183	0.176
MS_2	1.943	1.947	1.945	0.567	0.580	0.574	0.464	0.465	0.464	0.165	0.180	0.173
MS_3	1.917	1.922	1.919	0.560	0.573	0.567	0.460	0.462	0.461	0.164	0.179	0.171
S.Em±	0.015	0.013	0.013	0.006	0.006	0.006	0.003	0.002	0.003	0.001	0.003	0.002
CD $_{(p= 0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seed Rates												
SR_1	1.983	1.987	1.985	0.582	0.595	0.589	0.478	0.480	0.479	0.168	0.184	0.176
SR_2	1.932	1.936	1.934	0.556	0.569	0.562	0.460	0.461	0.460	0.165	0.179	0.172
SR_3	1.883	1.888	1.886	0.555	0.568	0.561	0.449	0.450	0.450	0.164	0.179	0.172
SR_4	1.973	1.977	1.975	0.577	0.590	0.584	0.466	0.464	0.465	0.167	0.182	0.175
SR_5	1.963	1.967	1.965	0.565	0.578	0.572	0.464	0.465	0.465	0.165	0.179	0.172
S.Em±	0.025	0.027	0.026	0.008	0.007	0.007	0.007	0.007	0.007	0.002	0.003	0.003
CD $_{(p= 0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Potassium content (%) and uptake (kg ha^{-1}) by wheat as influenced by methods of sowing and seed rates during year 2015-16 and 2016-17

Treatments	Potassium Content (%)					
	Grain			Straw		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Methods of Sowing						
MS_1	0.602	0.603	0.603	0.938	0.936	0.937
MS_2	0.592	0.597	0.595	0.920	0.921	0.921
MS_3	0.585	0.585	0.585	0.916	0.914	0.915
S.Em±	0.004	0.005	0.004	0.007	0.008	0.007
CD $_{(p= 0.05)}$	NS	NS	NS	NS	NS	NS
Seed Rates						
SR_1	0.608	0.611	0.610	0.947	0.946	0.947
SR_2	0.586	0.586	0.586	0.916	0.916	0.916
SR_3	0.571	0.575	0.573	0.904	0.901	0.903
SR_4	0.604	0.608	0.606	0.930	0.927	0.929
SR_5	0.595	0.596	0.596	0.926	0.927	0.926
S.Em±	0.009	0.009	0.009	0.011	0.012	0.011
CD $_{(p= 0.05)}$	NS	NS	NS	NS	NS	NS

Table 3: Available NPK (kg ha^{-1}) status in soil after crop harvest as influenced by methods of sowing and seed rates during year 2015-16 and 2016-17

Treatments	Available nutrient in soil (kg ha^{-1})								
	Available N			Available P_2O_5			Available K_2O		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Methods of Sowing									
MS_1	195.3	195.8	195.5	20.75	20.90	20.82	308.30	307.33	307.22
MS_2	190.9	191.1	191.0	20.45	20.66	20.55	306.21	306.53	306.37
MS_3	187.8	188.2	188.0	20.44	20.55	20.49	305.10	305.42	305.26
S.Em±	0.54	0.65	0.54	0.17	0.30	0.23	0.48	0.35	0.37
CD $_{(p= 0.05)}$	1.61	1.94	1.61	NS	NS	NS	1.45	1.06	1.10
Seed Rates									
SR_1	196.8	197.7	197.2	21.22	21.37	21.29	311.86	310.15	310.01
SR_2	194.9	195.8	195.0	20.93	21.09	21.01	308.77	309.06	308.92
SR_3	192.1	193.4	192.2	20.49	20.64	20.56	305.44	305.73	305.58
SR_4	186.9	187.6	187.3	20.19	20.35	20.27	303.86	304.16	304.01
SR_5	186.7	187.8	186.9	19.89	20.05	19.97	302.75	303.04	302.90
S.Em±	0.46	0.51	0.58	0.40	0.37	0.37	0.39	0.46	0.24
CD $_{(p= 0.05)}$	1.38	1.52	1.73	NS	NS	NS	1.18	1.37	0.73
Initial value	Available N-216.86			Available P_2O_5-14.78			Available K_2O-267.15		

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