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Impact of methods of sowing, FYM and seed treatment on growth, yield attributes, grain yield and quality of late sown wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted during revision of 2018-19 and 2019-20 at Students' Instructional Farm CSA University of Agriculture and Technology, Kanpur with a view to find out the effect of FYM, methods of sowing and seed treatment on growth, yield attributes, yield and net income of late sown wheat. The 18 treatment combination were tested in split plot design with 3 replication on the basis of 2 years experiment result it was revealed that regarding the methods of sowing significantly better growth, yield attributes, grain yield (39.499 q ha^{-1}), protein content (%) in grain (12.022%) and protein yield (475.892 q ha^{-1}) was received in criss-cross sowing method followed by line sowing method significant growth, yield attributes and grain yield (37.307 q ha^{-1}), protein content (%) in grain (11.737%), and protein yield (438.587 q ha^{-1}) while the minimum growth, yield attributes, grain yield (34.128 q ha^{-1}), protein content (%) in grain (11.469%) and protein yield (392.816 q ha^{-1}) was received in broadcasting method. Under nutrient management practices RDF + 10 tons FYM per hectare showed that significantly highest growth, yield attributes, grain yield (38.819 q ha^{-1}), protein content (%) in grain (11.887%) and protein yield (462.262 q ha^{-1}) while the minimum growth, yield attributes, grain yield (35.137 q ha^{-1}), protein content (%) in grain (11.599%) and protein yield (409.268 q ha^{-1}) was received in RDF alone. In case of seed treatment seed treated with 0.5% Zn solution was significantly growth, yield attributes and grain yield (39.762 q ha^{-1}), protein content (%) in grain (12.165%), and protein yield (484.554 q ha^{-1}) followed by water soaked seed significant higher growth, yield attributes and grain yield (36.630 q ha^{-1}), protein content (%) in grain (11.712%), and protein yield (429.430 q ha^{-1}) while the minimum growth, yield attributes, grain yield (34.542 q ha^{-1}), protein content (%) in grain (11.351%) and protein yield (393.310 q ha^{-1}) was received in dry seed.

Keywords: FYM, late sown wheat, methods of sowing and seed treatment

Introduction
Wheat (*Triticum aestivum* L.) is a most important staple food crop of the world which grown ancient time in the world and known as 'king of cereal' belong to the family 'Poaceae'. In India, wheat is the second most important cereal crop next only to rice and a key crop of the green revolution in post green revolution era. India stands second among the wheat producing countries after China. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. It is cultivated globally on an area of (223 m ha). with the production of (737 m t) of grains annually to the world food basket, with an average productivity of 3235 kg ha^{-1} It's the most important *Rabi* cereal crop of India, cultivated on an area of (31 m ha) with the production of (98.38 m t), with productivity of 3216 kg ha^{-1} 85 per cent area of wheat grown under irrigated condition. In Uttar Pradesh, wheat is cultivated an area of (9.70 m ha.) with the production of (30.50 m t) and productivity of 3150 kg ha^{-1}. (2019-20 DAC & FW). Thus we have to increase the production and productivity to full fill food demand. Due to continuous use of huge amount of synthetic chemical fertilizers without use of organic sources and intensive system of cultivation practices, there is change in soil physio-chemical condition, biological properties of soil and nutritional deficiencies are common in general and specifically with micronutrients which are very essential for plants.

In this endeavour proper blend of organic and inorganic fertilizers is important not only for increasing yield but also for sustaining soil health, when wheat is sown in the month of December there is a drastic reduction in yield November onwards delay in sowing by each day causes reduction of 41.6 Kg in north-western plain and 5 kg per day per hectare in north-eastern plain of country. Inspite of the development of the best production technology late sown usually results. In a poor stand as well as the inadequate vegetative growth of the crop.

Materials and Methods

A field experiment was conducted during rabi season 2018-19 and 2019-20 at Student Instructional Farm CSA University of Agriculture and Technology, Kanpur (U.P.) having sandy loam soil low in available N (211.5 kg ha^{-1}), medium in available P (15.68 kg ha^{-1}) and K (232.3 kg ha^{-1}) with pH (7.5). The experiment was carried out in split plot design with 3 replication of 18 treatment combination. The main plot consisted of 3 methods of sowing *viz*. broadcasting, line sowing and criss-cross sowing. The sub-plot consisted nutrient management *viz*. RDF 100% alone and RDF 100% + 10 tons FYM ha^{-1}. The sub-subplot consisted 3 seed treatment *viz*. dry seed, water soaked seed and seed soaked with 0.5% Zn solution. Wheat var. (K-9423 Unnat Halna) was sown 20 cm apart and per treatment sowing method with seed rate of 125 kg ha^{-1} treated as per treatment. The crop received uniform recommended dose of fertilizer @ 100 kg N, 60 kg P and 40 kg K ha^{-1} in all treatments along with 10 tons FYM ha^{-1} was also applied as per treatment. Half dose of N and full dose of P and K there apply as basal dose at the time of sowing. The remaining N was applied after first irrigation at crown root initiation (CRI Stage). The observations were recorded as per objectives for study the crop was harvested on proper maturity in both the years. Protein content in grain was obtained by multiplying the nitrogen content in grain with factor 6.25

Protein (%) = N (%) x factor 6.25

The protein yield (q ha^{-1}) was obtained by the following formula

Protein yield (q ha^{-1}) = Protein content (%) x yield (q ha^{-1}) /100

Result and Discussion

Growth and Yield Attributes of Wheat

Methods of sowing significantly influenced the plant population at 60 DAS, fresh weight at 90 DAS, dry weight at 90 DAS, number of ear head (m^{-2}), grain weight ear^{-1} and test weight (g) (Table 1). The criss-cross sowing methods showed the significantly highest number of plant (488.715 m^{-2}), fresh weight at 90 DAS (142.584 g), dry weight at 90 DAS (18.373 g), number of ear head (450.5 m^{-2}), grain weight ear^{-1} (2.558 gm) and test weight (37.662 gm) followed by line sowing method plant population at 60 DAS (460.732 m^{-2}), fresh weight at 90 DAS (134.175 g), dry weight at 90 DAS (17.368 g), number of ear head (432.943 m^{-2}), grain weight ear^{-1} (2.422 gm) and test weight (36.891 gm) while the minimum was recorded the number of plant population (433.187 m^{-2}), fresh weight at 90 DAS (124.182 g), dry weight at 90 DAS (15.845 g), number of ear head (413.5 m^{-2}), grain weight ear^{-1} (2.208 gm) and test weight (36.067 gm) in broadcasting method.

Under nutrient management practices RDF + 10 tons FYM ha^{-1} gave significantly better plant population (483.994 m^{-2}), fresh weight at 90 DAS (137.467 g), dry weight at 90 DAS (17.939 g), number of ear head (445.352 m^{-2}), grain weight ear^{-1} (2.499 gm) and test weight (37.384 gm) while the lowest was recorded plant population (466.750 m^{-2}), fresh weight at 90 DAS (129.827 g), dry weight at 90 DAS (14.452 g), number of ear head (419.289 m^{-2}), grain weight ear^{-1} (2.292gm) and test weight (36.362 gm) in RDF alone.

In case of seed treatment significantly highest plant population (490.933 m^{-2}), fresh weight at 90 DAS (141.202 g), dry weight at 90 DAS (18.526 g), number of ear head (455.877 m^{-2}), grain weight ear^{-1} (2.578 gm) and test weight (37.762 gm) was recorded in seed soaked with 0.5% Zn solution followed by water soaked seed number of plant population (462.337 m^{-2}), fresh weight at 90 DAS (133.417 g), dry weight at 90 DAS (17.043 g), number of ear head (428.158 m^{-2}), grain weight ear^{-1} (2.373 gm) and test weight (37.119 gm) while the minimum number of plant population (432.697 m^{-2}), fresh weight at 90 DAS (126.322 g), dry weight at 90 DAS (16.017 g), number of ear head (412.913 m^{-2}), grain weight ear^{-1} (2.235 gm) and test weight (35.663 gm) was received in dry seed.

Table 1: Impact of Method of sowing, FYM and Seed treatment treatments on growth and yield attributes of late sown wheat.

Treatments	Plant Population at 60 DAS (m^{-2})	Fresh Weight at 90 DAS (g)	Dry Weight at 90 DAS (g)	Number of ear head (m^{-2})	Grain weight ear^{-1} (g)	Test weight (g)
Main Plots (Methods of Sowing)						
M1- Broadcasting	433.187	124.18	15.84	413.503	2.208	36.067
M2- Line sowing	460.732	134.17	17.36	432.943	2.422	36.891
M3- Criss-cross sowing	488.715	142.58	18.37	450.500	2.558	37.662
S.E(d)±	4.915	1.94	0.22	3.680	0.031	0.193
CD at (5%)	13.645	3.16	0.51	9.004	0.071	0.445
F_1- RDF (100:60:40 kg N.P.K. ha^{-1})	446.750	129.82	16.45	419.279	2.292	36.362
F_2- RDF + 10 tons FYM ha^{-1}	483.894	137.46	17.93	445.352	2.499	37.384
S.E(d)±	3.780	1.38	0.15	2.834	0.017	0.142
CD at (5%)	9.251	3.00	0.33	6.175	0.038	0.308
S_1- Dry seed	432.697	126.32	16.01	412.913	2.235	35.663
S_2- Water-soaked seed	462.337	133.41	17.04	428.158	2.373	37.194
S_3- Seed-soaked with 0.5% Zn solution	490.933	141.20	18.52	455.877	2.578	37.762
S.E(d)±	4.969	1.84	0.20	3.575	0.026	0.180
CD at (5%)	10.255	3.71	0.41	7.193	0.052	0.362

Yield and Quality

Grain yield (q ha^{-1}), straw yield (q ha^{-1}), harvest index (%), protein content (%) in grain and protein yield (q ha^{-1}) was influenced significantly due to different methods of sowing, nutrient management and seed treatment (Table 2). The criss-cross sowing method showed significantly highest grain yield (39.499 q ha^{-1}), straw yield (63.053 q ha^{-1}), harvest index (38.487%), protein content (12.022%) in grain and protein yield (475.892 q ha^{-1}) as compare to other methods of sowing. The line sowing method was also gave significantly higher grain yield (37.307 q ha^{-1}), straw yield (60.673 q ha^{-1}), harvest index (38.060%), protein content (11.737%) in grain and protein yield (438.587 q ha^{-1}) while the minimum grain yield (34.128 q ha^{-1}), straw yield (56.405 q ha^{-1}), harvest index (37.673%), protein content (11.469%) in grain and protein yield (392.816 q ha^{-1}) was received in broadcasting method.

Under nutrient management practices RDF + 10 tons FYM ha^{-1} gave significantly higher grain yield (38.819 q ha^{-1}), straw yield (62.440 q ha^{-1}), harvest index (38.312%), protein content (11.837%) in grain and protein yield (462.262 q ha^{-1}) over RDF alone grain yield (35.137 q ha^{-1}), straw yield (57.648 q ha^{-1}), harvest index (37.835%), protein content (11.599%) in grain and protein yield (409.268 q ha^{-1}).

In case of seed treatment seed treated with 0.5% Zn solution produced significantly highest grain yield (39.762 q ha^{-1}), straw yield (63.408 q ha^{-1}), harvest index (38.527%), protein content (12.165%) in grain and protein yield (484.551 q ha^{-1}) over rest of the treatments. Watersoaked seed was also capable to produced significantly better grain yield (36.630 q ha^{-1}), straw yield (59.776 q ha^{-1}), harvest index (38.048%), protein content (11.712%) in grain and protein yield (429.430 q ha^{-1}) while the minimum grain yield (34.542 q ha^{-1}), straw yield (57.148 q ha^{-1}), harvest index (37.646%), protein content (11.351%) in grain and protein yield (393.310 q ha^{-1}) was obtained in dry seed.

Table 2: Impact of Method of sowing, FYM and Seed treatment treatments on yield and quality of late sown wheat.

Treatments	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Harvest index (%)	Protein content (%)	Protein yield (q ha^{-1})
Main Plots (Methods of Sowing)					
M1- Broadcasting	34.12	56.40	37.67	11.46	392.81
M2- Line sowing	37.30	60.67	38.06	11.73	438.58
M3- Criss-cross sowing	39.49	63.05	38.48	12.02	475.89
S.E(d)±	0.52	1.07	0.09	0.04	5.29
CD at (5%)	1.21	2.48	0.22	0.11	7.79
Sub-Plot (Nutrient Management)					
F_1- RDF (100:60:40 kg N.P.K. ha^{-1})	35.13	57.64	37.83	11.59	409.26
F_2- RDF + 10 tons FYM ha^{-1}	38.81	62.44	38.31	11.88	462.26
S.E(d)±	0.38	0.56	0.07	0.03	3.93
CD at (5%)	0.83	1.24	0.16	0.07	9.63
Sub-sub plot treatments (Seed treatments)					
S_1- Dry seed	34.54	57.14	37.64	11.35	393.31
S_2- Water-soaked seed	36.63	59.57	38.04	11.71	429.43
S_3- Seed-soaked with 0.5% Zn solution	39.76	63.40	38.52	12.16	484.55
S.E(d)±	0.60	0.69	0.07	0.04	7.16
CD at (5%)	1.21	1.40	0.18	0.08	14.40

Interaction Effect

Interaction effect of methods of sowing, nutrient management and seed treatment was not found significant in case of plant population at 60 DAS, fresh weight at 90 DAS, dry weight at 90 DAS, number of ear head (m^{-2}), grain weight ear^{-1} and test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}), harvest index (%), protein content (%) in grain and protein yield (q ha^{-1}) while the highest was recorded in the combination of criss-cross sowing method along with RDF + 10 tons FYM ha^{-1} and seed soaked with 0.5% Zn solution.

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