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Studies on scaling up of seed yield and its quality parameters in wheat (*Triticum aestivum* L.)

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Abstract: An investigation was carried out during *rabi* season of 2012 and 2013 for developing appropriate agronomic practices for seed production of wheat variety PBW 502. Twenty four treatments *i.e.* combinations of two sowing methods, three levels of fertilizer doses (NPK) and four levels of zinc sulphate, were laid out in 3 factor factorial randomized complete block design *i.e.* split-plot design with three replications. Methods of sowing were kept in main plots with different levels of fertilizer doses and zinc sulphate as Split Plots. Periodical observations were recorded on growth, yield attributing characters and grain yield. The results revealed that various methods of sowing and varied levels of NPK had significant effect on seed yield and its quality parameters like germination (%), germination rate, seedling length and vigour index. Increasing levels of zinc sulphate significantly increased the germination rate and vigour index. Highest seed yield (54.77 q ha^{-1} and 56.41 q ha^{-1}) was obtained from the plants sown on ridges. Maximum seed yield potential can be obtained under ridge method of sowing along with the application of RDF + 25% higher dose and zinc sulphate @ 30 kg ha^{-1} as these combinations resulted into good quality seeds which were also permissible to standard seed health status.

Key words: Wheat, Sowing methods, Zinc sulphate, NPK

Introduction

Wheat (*Triticum aestivum* L.), being an important cereal crop, is used in various forms by more than one thousands million human beings in the world. It is a predominant winter (*rabi*) crop of North-Western Plain Zone and Central zone of India. The major wheat growing states in the country are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and Jammu & Kashmir. India needs more food grain year ahead as the population is increasing unabated. The demand for wheat by 2020 is projected to be 105-109 million tonnes against the production of 93.90 million tonnes during 2011-2012. Most of this increase in production is a big challenge that cannot be met only by increasing the area under production until and unless quality seed is produced. Since wheat is a self pollinating crop and the grain can be used as seed, farmers tend to replant their own seed. It is, therefore, expected that in the future the large majority of resource-poor, small-scale farmers in many developing countries will have to rely on seed saved from the previous harvest. The availability, access and use of seed of adaptable modern varieties is determinant to the efficiency of packages of practices such as sowing methods, irrigation, fertilizers, pesticides etc in increasing crop production to enhance food security and alleviating rural poverty in developing countries. Therefore, the best production techniques need to be followed to produce good quality seed.

In the era of *Green Revolution*, scientists made many new dwarfing varieties of wheat those are responsive to increased doses of fertilizers. To the farmer all the scientific research would be of little value unless he gets seeds, which are genetically pure (true to type) and possess other desired qualities namely, high germination percentage and vigour, high purity, sound health, etc. Only seeds with assured quality can be expected to respond to fertilizers and other inputs in the expected manner. If a seed lot meets the certification standard, it is good quality seed and if it does not meet the certification standards, it is obviously of a lower seed quality. Scaling up of seed yield is an integral approach for achieving the goal for feeding population and national food security. Keeping above points in view, the present investigation was carried out to analyse the comparative performance of ridge and flat bed methods, and to optimize the doses of NPK and zinc sulphate for seed crop of wheat (Hossain *et al.,* 2009, Sumer *et al.,* 2010, Alam, 2012 and Dagash *et al.,* 2014). Keeping in view, the present investigation was carried out with objectives: To optimize the stage of harvesting befitting the highest quality seed parameters.

Materials and Methods

Two consecutive experiments were carried out at Crop Research Station, Masodha of N. D. University of Agriculture and Technology during rabi season of 2012 and 2013. The climate of Faizabad is semi-arid to sub-humid with hot summer and cold winter.

Twenty four treatments *i.e.* combinations of two sowing methods, three levels of fertilizer doses (NPK) and four levels of zinc sulphate, were laid out in 3 factor Factorial Randomized Complete Block Design *i.e.* split-plot design with three replications. Methods of sowing were kept in main plots with different levels of fertilizer doses and zinc sulphate as Split Plots. The soil of experimental field was suitable being neutral in reaction (pH 7.4) and weather conditions during crop period seemed to be favourable for successful outcome of the wheat crop. Periodical observations were taken in order to assess the effect of sowing methods, fertilizer doses and zinc sulphate on seed yield and its quality parameters which were analyzed statistically. Seed health status of the seed lots obtained from each treatment was determined by dry inspection method against Karnal bunt disease.

Results and Disucssion

The findings of the present investigation have been elaborated and discussed under following heads.

Effect of sowing methods: Analysis of variance (Table 1) showed that various method of sowing had significant response on seed yield during both the years of study. Higher seed yield of 54.77 q ha^{-1} and 56.41 q ha^{-1} was obtained under ridge method of sowing than flat method during 2012-13 and 2013-14, respectively (Table-2). This method of sowing was presumed to have increased seed yield by 11.45% and 12.63% over flat method during 2012-13 and 2013-14, respectively. Khan *et al.* (2000) reported that sowing method greatly affected seed yield. Siddiqui *et al.* (2006), El-Lattief (2011) and Dagash *et al.* (2014) obtained maximum seed yield of wheat with ridge sowing over other methods.

Among the seed quality parameters, germination (%), germination rate, seedling length (cm) and vigour index were significantly influenced by the methods of sowing during both the years of study (Table-1). Higher germination (87.20% and 86.60%) was recorded under ridged bed method of sowing than flat bed method during 2012-13 and 2013-14, respectively (Table-2). Phogat (2007) reported significant response of germination sowing methods. Significantly higher germination rate of 18.47 and 17.61 was observed under ridged bed method of sowing than flat bed method during 2012-13 and 2013-14, respectively (Table-2). Seed vigour is described as the performance of seeds when sown in the field which largely depends on the growing conditions of seed crop as well as germination per cent of seed lot and length of seedlings. The results obtained over two years (Table-2) showed that maximum seedling length of 18.75 cm and 17.95 cm, and vigour index (1635.86 and 1556.25) were recorded under ridge bed method of sowing than flat bed method during 2012-13 and 2013-14. This gave increase of about 2.5-3.5 cm in seedling length and about 385-445 in vigour index of seedlings under ridge bed method of sowing over flat bed method. The significant effects of method of sowing on seedling length and vigour index have also been reported by Kataria and Sharma (2007).

Effect of NPK fertilizers: During the past three decades, intensive agriculture involving exhaustive high yielding varieties has led to heavy withdrawal of nutrients from the soil. Fertilizer application to seed crops should be based on local recommendations. A well-balanced supply of nitrogen, phosphorus and potassium (NPK) is essential for seed production as it has an influence on seed development and thereby on seed quality. From the findings of present investigation, the varied doses of fertilizer had significant response on seed yield during both the years (Table-1). In 2012-13, highest seed yield (52.92 q ha^{-1}) was recorded under the treatment of RDF + 50% higher dose, which was *at par* with RDF + 25% higher dose and significantly superior to RDF (Table-2). Similarly in 2013-14, highest seed yield (54.12 q ha^{-1}) was recorded under the treatment of RDF + 50% higher dose, which was significantly superior to other doses of NPK fertilizer. Similar findings were also reported by Hossain *et al.* (2009), Sumer *et al.* (2010), Alam (2012) and Dagash *et al.* (2014).

Germination (%), germination rate, seedling length (cm) and vigour index are important quality parameters of seed which were significantly influenced by the varied dose of NPK fertilizers (Table-1). In 2012-13, the varied doses of NPK fertilizer had non-significant effect on germination per cent (Table-1). In 2013-14, significantly maximum germination of 81.95% was observed under the treatment of RDF + 50% higher dose, which was statistically *at par* with RDF + 25% higher dose (Table-2). A significant increase in germination rate was observed with increasing doses of NPK fertilizer during both the years of present investigation. Maximum germination rate of 18.97 and 17.94 were observed under the treatment of RDF + 50% higher dose during 2012-13 and 2013-14, respectively (Table-2). Seed vigour is the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence. Increasing doses of NPK fertilizer over RDF had also shown significant increase in seedling length and vigour index during both the years (Table-1). Application of RDF + 50% higher dose to seed crop significantly increased the seedling length by 5 cm recording highest seedling length of 20.05 cm and 19.19 cm, and vigour index by 475 recording 1665.13 and 1588.26 during 2012-13 and 2013-14, respectively. The higher seed quality under this treatment may be due to better filled seeds and better nutrient availability and its uptake by mother plant. The quality parameters were significantly affected by the plants nutrients as reported by Ragasits *et al.* (2000), Abad *et al.* (2004) and Patil *et al.* (2008).

Effect of zinc sulphate: Analysis of variance (Table-1) showed that seed yield did not respond to increasing levels of zinc sulphate during both the years. However, maximum values of seed yield (52.31 q ha^{-1} and 53.48 q ha^{-1}) were recorded with the application of zinc sulphate @ 40 kg ha^{-1} (Table-2). Tiwari *et al.* (2006), Ramkala *et al.* (2008) and Aslam and Yadav (2009) reported that wheat seed yield was greater with the lower Zn rates. Among seed quality parameters, seed germination (%) and seedling length (cm) were non-significantly affected by the application of zinc sulphate (Table-1). Highest germination rate was observed with the application of zinc sulphate @ 30 kg ha^{-1}, which was statistically *at par* with zinc sulphate @ 40 kg ha^{-1} (Table-2). Seed vigour is an important quality parameter since it is not always possible to get an idea of performance of seed lot in the field on the basis of germination test in laboratory. The vigour index of seedlings has varied significantly with the varied levels of zinc sulphate (Table-1) which really indicated the overall seed quality.

Table-1: ANOVA summary for seed yield (q ha^{-1}) and its quality parameters in wheat cv. PBW 502 during 2012-13 and 2013-14

Source of variation	d.f.	Mean Sum of Squares									
		Seed yield (q ha^{-1})		Germination (%)		Germination rate		Seedling length (cm)		Vigour index	
		2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Replication	2	0.027	0.880	0.044	0.368	0.019	6.124	0.215	0.084	1811.621	1242.368
Methods of sowing (S)	1	516.168**	721.873**	1921.587**	1812.020**	127.920*	72.040*	191.329**	127.947**	3559561.186**	2674868.974**
Error (a)	2	1.095	5.090	7.902	0.152	2.667	2.667	0.150	0.142	1765.107	969.498
Fertilizer doses (F)	2	19.760**	16.405**	2.759	5.947*	108.682**	71.174**	185.181**	140.042**	1368927.616**	1073990.985**
Interaction (S×F)	2	0.000	0.000	0.000	2.000	1.995**	1.998**	23.014**	48.222**	217796.326**	414172.971**
Zinc sulphate (Z)	3	0.661	0.730	1.963	0.504	0.202*	0.956**	0.755	0.637	8829.499*	5772.273*
Interaction (S×Z)	3	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	30.243	25.043
Interaction (F×Z)	6	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	118.753	1.157
Interaction (S×F×Z)	6	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	104.780	0.523
Error (b)	44	1.930	1.335	1.226	1.241	0.070	0.102	0.332	0.266	2370.310	1769.663

Table-2: Mean values of seed yield (q ha^{-1}) and its quality parameters in wheat cv. PBW 502 during 2012-13 and 2013-14

Treatment	Seed yield (q ha^{-1})		Germination (%)		Germination rate		Seedling length (cm)		Vigour index	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Method of sowing										
Ridge method	54.77	56.41	87.20	86.60	18.47	17.61	18.75	17.95	1635.86	1556.25
Flat method	49.41	50.08	76.86	76.57	15.81	15.61	15.49	15.29	1191.16	1170.76
Sem (±)	0.174	0.376	0.469	0.065	0.272	0.272	0.065	0.063	7.002	5.190
C.D. (p=0.05)	1.06	2.29	2.85	0.39	1.66	1.66	0.39	0.38	42.61	31.58
Fertilizer doses (NPK kg ha^{-1})										
RDF (120:60:40)	51.12	52.47	81.69	81.02	14.80	14.67	14.53	14.40	1189.95	1168.29
RDF + 25% higher dose (150:75:50)	52.22	53.14	82.04	81.79	17.64	17.22	16.78	16.26	1385.45	1333.96
RDF + 50% higher dose (180:90:60)	52.92	54.12	82.36	81.95	18.97	17.94	20.05	19.19	1665.13	1588.26
Sem (±)	0.284	0.236	0.226	0.2273	0.054	0.065	0.118	0.105	9.938	8.587
C.D. (p=0.05)	0.81	0.67	NS	0.65	0.15	0.19	0.34	0.30	28.32	24.47
Zinc sulphate (kg ha^{-1})										
10 kg ha^{-1}	51.84	53.00	81.73	81.39	17.00	16.33	16.86	16.35	1387.16	1338.08
20 kg ha^{-1}	52.08	53.18	81.82	81.55	17.11	16.56	17.07	16.65	1405.90	1365.26
30 kg ha^{-1}	52.12	53.30	82.10	81.60	17.22	16.89	17.21	16.71	1422.05	1371.29
40 kg ha^{-1}	52.31	53.48	82.47	81.80	17.20	16.67	17.34	16.77	1438.93	1379.38
Sem (±)	0.328	0.272	0.261	0.263	0.062	0.075	0.136	0.122	11.475	9.915
C.D. (p=0.05)	NS	NS	NS	NS	0.18	0.21	NS	NS	32.71	28.26

The maximum vigour index (1438.93 and 1379.38) was recorded under zinc sulphate @ 40 kg ha^{-1}, closely followed by the zinc sulphate @ 30 kg ha^{-1} during 2012-13 and 2013-14, respectively.

Interaction effects: Sowing of seed on ridged beds increases crop yield by 10-20% with the proper variety, saves 30-40% irrigation water, reduces seed rate, promotes higher nitrogen use efficiency, reduces production cost over the conventional system (BARI, 2006). There are indications that yields of wheat on ridged beds can be further increased through applications of higher doses of fertilizers because of the reduced loss of lodging. Analysis of variance (Table-1) revealed that significant interactions between sowing methods and fertilizer doses have been registered for quality parameters of seed such as germination rate, seedling length (cm) and vigour index of seedlings were significantly affected due to interactions effects of sowing method and fertilizers. High germination percentage and vigour result to raising of an excellent crop having adequate plant population and uniform growth. Other possible interaction effects were found to be non-significant for most of the characters. This could be because of variable environmental conditions and genetic control of the variety.

Table-3: Mean values for Karnal bunt infection (%) in favour of seed health status of wheat cv. PBW 502 during 2012-13 and 2013-14

Treatment	2012-13	2013-14
Method of sowing		
Ridge method	None	None
Flat method	0.067	0.063
Sem (±)	-	-
C.D. (p=0.05)	-	-
Fertilizer doses (NPK – kg ha^{-1})		
RDF (120:60:40)	None	None
RDF + 25% higher dose (150:75:50)	0.074	0.070
RDF + 50% higher dose (180:90:60)	0.097	0.093
Sem (±)	-	-
C.D. (p=0.05)	-	-
Zinc sulphate (kg ha^{-1})		
10 kg ha^{-1}	None	None
20 kg ha^{-1}	None	None
30 kg ha^{-1}	None	None
40 kg ha^{-1}	None	None
Sem (±)	-	-
C.D. (p=0.05)	-	-

Seed health status: The health of seed refers to the presence or absence of disease organisms/insect pests on seeds. The quality of a seed lot vary much depends on its health. Infected seeds with Karnal bunt disease had a characteristic black powdery mass along the suture. In Uttar Pradesh this disease was first reported in 1942, and since then this has been reported from several districts of Western Uttar Pradesh. Elsewhere in the country this is unknown. Though the disease is of less importance, yet in certain years it caused heavy damage (Pandey, 1982). The data presented in Table-3 refer to seed health status of wheat against Karnal bunt disease. The various sowing methods and fertilizer doses affected the infection percentage of the disease. In case of sowing methods, the ridge method of sowing did not have any infected seed in seed lot. However, infection of the disease was recorded as 0.067% and 0.063% under flat method during 2012-13 and 2013-14, respectively. Increasing doses of NPK fertilizers resulted into increase of infected seeds recording 0.074% and 0.070% with 25% higher dose, and 0.097% and 0.093% with 50% higher dose over RDF during 2012-13 and 2013-14, respectively. None of the infected seeds was found in seed lot taken from the pots treated with RDF and varied levels of zinc sulphate. Generally heavy doses of fertilizer make crop plants more attractive to the attack of diseases and pests. However, none of the infected seeds was found with ridge method of sowing, recommended dose of fertilizer and varied levels of zinc sulphate. Agrawal (1995) has mentioned that maximum 0.10% of plants/heads affected by designated diseases in wheat are permissible for foundation seed production.

It is concluded from the present findings that wheat crop should be sown on ridges and the plant nutrients namely nitrogen, phosphorus and potassium be applied in the ratio of 150:75:60 kg ha^{-1} along with zinc sulphate @ 30 kg ha^{-1} for obtaining high seed yield potential of the variety producing good quality seeds and healthy disease free seeds.

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