Yield of spring wheat depending on the level of mineral nutrition and the use of biologically active substances under condition grown of Afghanistan

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Abstract. A field experiments was carried out at the experimental farm department of Agronomy, Agriculture faculty, Al-beruni University, Kapisa, Afghanistan, to study the effect of NPK and gibberellic acid on growth and yield of spring wheat during March-June 2022 and 2023. The experiment was arranged on randomized complete block design, with three replication. Treatments include: T_1 - $N_0P_0K_0$ (Control), T_2 – $N_1P_1K_1$ (120–60-30 kg/ha), T_3 – $N_2P_2K_2$ (160–90-60 kg/ha),T_4 – $N_3P_3K_3$ (200–120-90 kg/ha), T_5 – $N_1P_1K_1$ (120–60-30 kg/ha) + GA_3 200 ppm, T_6 – $N_2P_2K_2$ (160–90-60 kg/ha), + GA_3 200 ppm, T_7 – $N_3P_3K_3$ (200–120-90 kg/ha) + GA_3 200 ppm. In case of mineral fertilizers and gibberellic acid, results indicated that NPK levels and GA_3 with a few exceptions remarkably improved the yields attributes and yields of spring wheat. The highest 1000 grain weight (46.98 and 47.18 gr), grain yield (4.16 and 4.63 t/ha) and straw yield of spring (8.48 and 8.55 t/ha) wheat was recorded with application of 160–90-60 Kg/ha NPK + 200 ppm GA_3 in both years of 2022 and 2023. While the minimum was found in control treatment.

1 Introduction

Afghanistan is an agricultural country that the majority of its population is directly and indirectly employed in the agriculture sector and makes a living through this. Wheat is one of the basic food grains and it constitutes about 70 percent of the production of cereals in Afghanistan. Wheat is the basic food of Afghan people and provides more than half of the country's caloric needs and plays a vital role in providing food security and nutrition. Statistics show that Afghanistan has nearly 7.5 million hectares of arable land, among which about 3.5 million hectares are dedicated to the cultivation of various agricultural products. Including 2.3 million hectares of land under wheat cultivation. Factors such as unbalanced application of fertilizers increase of pests and crop disease, droughts, changing farming practices, and land preparation are among the factors that reduce wheat productivity in Afghanistan [1].

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Fertilization is one of the most important parts of the crop growing technology and has the highest dynamic effect on the grain wheat yield economically [2]. Mineral fertilization of spring wheat determines the quantity and quality of obtained grain yield. It is particularly essential to balance mineral fertilization with nitrogen, phosphorus and potassium [3]. The combined use of NPK fertilizers plays an important role in wheat production. Application of NPK in balanced share at proper time has great impact on wheat yield. Nitrogen plays a vital role in growth processes as it is an integral part of chlorophyll, protein and nucleic acid. It is viewed as the central element because of its role in substance synthesis. It constitutes 1.5 to 5 percent of the dry weight of higher plant. Phosphorous insufficiency is common in most of the soils of Afghanistan and application of phosphatic fertilizer is considered crucial for crop production [4]. Nitrogen (N), phosphorus (P), and potassium (K) are primary nutrients in crop nutrition. Nitrogen (N) is a primary constituent of proteins, enzymes, chlorophyll, and metabolic processes involved in the synthesis and transfer of energy [5]. Plant growth regulators have potential to increase grain yield and may also alter grain protein levels of cereal crops especially wheat [6]. Gibberellins are an important group of diterpene plant hormones that control diverse aspects of growth and development of plants from germination to flowering to seed formation [7, 8], Gibberellic acid (GA_3), an important signalling plant hormone, stimulate various plant developmental and physiological processes, that includes seed germination, flowering, cell division and maturity, root formation, etc. GA_3 also enhances the tolerance of plants to environmental stresses including salt, chilling, drought and trace element stress [9].

2 Materials and methods

A field experiments was carried out at the experimental farm department of Agronomy, Agriculture faculty, Al-beruni University, Kapisa, Afghanistan, to study the effect of NPK and gibberellic acid on growth and yield of spring wheat during March-June 2022 and 2023. The experiment was arranged on randomized complete block design with three replication. Treatments include: T_1 - $N_0P_0K_0$ (Control), T_2 – $N_1P_1K_1$ (120–60-30 kg/ha), T_3 – $N_2P_2K_2$ (160–90-60 kg/ha),T_4 – $N_3P_3K_3$ (200–120-90 kg/ha), T_5 – $N_1P_1K_1$ (120–60-30 kg/ha) + GA_3 200 ppm, T_6 – $N_2P_2K_2$ (160–90-60 kg/ha), + GA_3 200 ppm, T_7 – $N_3P_3K_3$ (200–120-90 kg/ha) + GA_3 200 ppm. NPK fertilizers and gibberellic acid was applied as per the treatment before sowing and at different growth stage. The variety of wheat that has been studied as experimental material is called Kabul 013. Statistical analysis of data was done online through OPSTAT software.

3 Results and discussion

1000 grain weight, grain yield and straw yield of spring wheat increased significantly due to NPK and gibberellic acid application (Table 1). There was a proportionate increase in yield of spring wheat with the increase in NPK dose and gibberellic acid up to 160–90-60 kg/ha NPK + 200 ppm GA_3, therefore maximum 1000 grain weight of spring wheat (46.98 gr and 47.18 during 2022 and 2023 years, was recorded with application 160–90-60 Kg/ha NPK + 200 ppm GA_3. While the minimum 1000 grain weight (37.85 and 35.85 gr) observed in control treatment respectively. So during 2022 year, it was statistically at par with all other treatments except 120–60-30 kg/ha NPK and control treatment, but during year 2023 application of 160–90-60 Kg/ha NPK + 200 ppm GA_3, except 200–120-90 Kg/ha NPK + 200 ppm GA_3 significantly differ from other treatments. It confirmed by [10], it indicates that application of over doses nitrogen fertilizer the grain weight

decreased. 1000- Grain weight significantly inreased by NPK fertilizers level [11, 12, 13]. Maximum 1000 grain weight of wheat was shown with application of 200 ppm GA_3 [14].

Grain yield of spring wheat improved remarkably due to different NPK levels and gibberellic acid. Application of 160–90-60 Kg/ha NPK + 200 ppm GA_3, had resulted in the highest grain yield (4.15 and 4.63 t/ha) of spring wheat during 2022 and 2023 years. This treatment was statistically at par with 200–120-90 Kg/ha NPK + 200 ppm GA_3, but it was significantly better over control and other treatments during 2022 year. Also use of 160–90-60 Kg/ha NPK + 200 ppm GA_3, in 2023 year had a significant effect on grain yield of spring wheat compared to other treatments. Reported that the application of N up to 150 kg/ha had significantly increased the grain yield of wheat [15]. Same results reported by (10, 16, 4). Maximum grain yield of spring wheat was found from use of 200 ppm GA3 [14]. Enhancement in growth and yield due to GA3 application compared to the control was observed. This might be due to more efficient consumption of food for reproductive growth (flowering and fruit set), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites. Inhibition of growth performance on exposure to the other plant regulators occurred [17]

Regarding straw yield use of 160–90-60 Kg/ha NPK + 200 ppm GA_3, produced highest straw yield (8.48 and 8.55 t/ha) of spring wheat during both years of 2022 and 2023. This treatment was significantly superior over control and other treatments, but it was statistically similar with 200–120-90 Kg/ha NPK + 200 ppm GA_3. At higher rate of NPK + GA_3 application more than 160–90-60 Kg/ha NPK + 200 ppm GA_3, diminishing trend was observed in straw yield of spring wheat. But the declines at higher dose of NPK + GA_3 were statistically identical with 200–120-90 Kg/ha NPK + 200 ppm GA_3. The per cent of straw yield penalty above 160–90-60 Kg/ha NPK + 200 ppm GA_3, was to the tune of 2.5% and 3.8% with the application of 200–120-90 Kg/ha NPK + 200 ppm GA_3, during both years respectively. Reported that the highest straw yield of wheat was recorded with application of 160 kg N/ha [10]. Maximum straw yield was obtained with application of 90 kg p/ha [18]. Highest straw yield was found from 200 ppm GA3 which was statistically similar with 100 ppm GA3 [14].

Table 1. Effect of different NPK and GA3 on 1000 grain weight, grain yield and straw yield of spring wheat.

Treatments	Year 2022			Year 2023		
	1000 grain weight (gr)	Grain yield t/ha	Straw yield t/ha	1000 grain weight(gr)	Grain yield t/ha	Straw yield t/ha
T_1	37.85	1.84	3.71	35.85	1.85	3.72
T_2	42.54	2.70	5.52	42.11	2.74	5.36
T_3	44.12	3.17	7.27	45.68	3.56	7.13
T_4	44.91	3.66	7.68	45.51	3.65	7.11
T_5	43.70	3.07	7.01	44.81	3.18	5.91
T_6	46.98	4.16	8.48	47.18	4.63	8.55
T_7	45.55	4.15	8.26	46.42	4.27	8.22
SEm±	1.34	0.071	0.17	0.43	0.065	0.11
CD (P=0.05)	4.17	0.22	0.55	1.35	0.20	0.35

T_1 - $N_0P_0K_0$ (Control), T_2 – $N_1P_1K_1$ (120–60-30 kg/ha), T_3 – $N_2P_2K_2$ (160–90-60 kg/ha),T_4 – $N_3P_3K_3$ (200–120-90 kg/ha), T_5 – $N_1P_1K_1$ (120–60-30 kg/ha) + GA_3 200 ppm, T_6 – $N_2P_2K_2$ (160–90-60 kg/ha), + GA_3 200 ppm, T_7 – $N_3P_3K_3$ (200–120-90 kg/ha) + GA_3 200 ppm.

4 Conclusion

Finally it can be concluded that application of 160–90-60 Kg/ha NPK + 200 ppm GA_3 increase yields attributes and yields of spring wheat in both years of 2022 and 2023. It was best treatment for all of the yield parameters, but it was statistically at par with 200–120-90 Kg/ha NPK + 200 ppm GA_3.

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