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EFFECT OF POTASSIUM APPLICATION ON GROWTH AND YIELD OF WHEAT VARIETIES

PRAKASH MAURYA[1], VINAY KUMAR[2], K. K. MAURYA[3], NARENDRA KUMAWAT[4], RAKESH KUMAR[5]* AND M. P. YADAV[6]
[1]Department of Agronomy, CSAU & T, Kanpur - 208 002, INDIA
[2] SMS (Soil Science), KVK, Munger BAU Sabour - 813 210, Bihar, INDIA
[3]Programme Assistant cum Lab Tech., KVK Munger, BAU Sabour - 813 210, INDIA
[4]SRF, ARS, Rajasthan Agricultural University, Bikaner - 334 006, INDIA
[5]ICAR RC for NEH Region, Nagaland Centre, Jharnapani - 797 106, INDIA
[6]Professor and Head, Agronomy, CSAU and T Kanpur - 208 002, INDIA
e-mail: rakeshbhu08@gmail.com

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***Corresponding author**

ABSTRACT

The field experiment was conducted at CSAUA&T Kanpur during *rabi* season of 2011-12 to study the effect of potassium levels on growth, yield and economics of wheat (*Triticum aestivum* L.) varieties. Treatments were consisting of three varieties of wheat *viz*. PBW-343, K-307 and K-402 and four potassium levels *viz*. 0, 40, 60 and 80 kg K ha^{-1} in factorial randomized complete block design with 3 replications. Significantly higher growth characters *viz*. no. of ear head (391.2 m^{-2}), effective tillers (266.4 m^{-2}) and total number of tillers (317.5 m^{-2}); yield attributes *viz*. length of $spike^{-1}$ (9.3 cm), no. of spikelets $spike^{-1}$ (19.9), weight $spike^{-1}$ (2.6 g), grains $spike^{-1}$ (46.30) and weight of grains $spike^{-1}$ (1.83 g) were recorded with PBW-343 followed by K-307 and the lowest in K-402. Similarly, the highest grain yield (48.8 q ha^{-1}), straw yield (69.7 q ha^{-1}) and biological yield (118.6 q ha^{-1}) were also recorded in wheat variety PBW-343. Gross returns (Rs. 80, 041 ha^{-1}), net returns (Rs.37, 620 ha^{-1}) and B: C ratio (1.88) was found in the variety PBW-343. Higher growth characters and yield attributes of wheat were reported with application of 80 kg K_2O ha^{-1}. Similarly, the highest grain yield (50.7 q ha^{-1}), straw yield (70.1q ha^{-1}), biological yield (120.9 q ha^{-1}) and harvest index (41.9%) were also recorded under 80 kg K_2O ha^{-1} which was at par with 60 kg K_2O ha^{-1}.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most staple and second most important food crop after rice in the country, which contributes nearly one-third of the total food grains production. It is consumed mostly in the form of bread as "Chapati". Wheat straw is used for feeding cattle. Wheat contains more protein than other cereal and has a relatively high content of niacin and thiamine. It is basically concerned in providing the characteristics substance "Glutin" which is very essential for bakers. The area under wheat was increased since the start of Green revolution in 1967 and production and productivity were also increased from 12.8 million hectare in 1966-67 to 257.4 m ha in 2011-12. In this period, production has also increased from 11.4 to 88.3 mt and productivity has gone up 887 kg ha^{-1} to 3140 kg ha^{-1}. Along with nitrogen and phosphorus, potassium is one of three essential macronutrients and is required by plants in relatively large amounts. The importance of potassium is evident from the fact that it is involved in more than 60 enzymatic systems in plant and is required for synthesis of proteins, vitamins, starch and cellulose. Potassium play an important role in maintenance of cellular organization by regulating permeability of cellular membranes and keeping protoplasm in proper degree of hydration by stabilizing emulsion of high colloidal properties. Potassium has a great buffering action and stabilizes various enzymes system. It play role in photosynthesis and translocation of food (sink) from leaves to seeds. It also enhances the plants ability to resist pest attack, moisture stress and cold condition. Adequate supply of this nutrient promotes the formation of fully developed grain with a high starch contents. Potassium is reported to improve the water relation as well as productivity of different crop under water stress conditions (Islam *et al.,* 2004). Several plant metabolic process and maintenance of cell are dependent on potassium in sap (Mengel and Kirkby, 1987). With adequate availability of these nutrients, crop achieved good yield. Selection of suitable varieties plays a vitral role in crop production, particularly in new areas of introduction. The choice of right varieties of wheat helps to augment the crop productivity. Thus, value of stable and high yielding varieties has been universally recognized as an important non-cash input for boosting production of any crop. Keeping this in view, the present investigation was carried out to evaluate the effect of potassium levels on growth and productivity of wheat varieties.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of 2011-12 at Students' Instructional Farm of College of

Agriculture at C.S.A.U.A & T. Kanpur (U.P.). The soil of the experimental field was sandy loam, having pH 7.3, organic carbon 0.46% and 173.0, 16.8 and 164.0 kg ha^{-1} available N, P and K, respectively. The treatments comprised of three wheat varieties *viz*. PBW-343, K-307 and K-402 and four potassium levels *viz*. 0, 40, 60 and 80 kg K ha^{-1}. The experiment was laid-out in a factorial randomized complete block design with three replications. The crop was shown on 2nd December 2011 at 20 cm row spacing with seed rate of 100 kg ha^{-1}. First irrigation was given at the CRI stage *i.e*. 21 days after sowing the three additional irrigations were given to the fulfillment of crop with 20-25 days interval. One hand weeding was done manually with the help of *khurpi* for clean cultivation of crop 30-35 days after sowing of crop. Plants were tagged randomly in net plots for recording growth and yield attributes of crop different treatments. Crop was harvested on 15th April 2012. The harvesting was done manually with the help of sickle. The harvested total dry matter production was weighed in field with the help of spring balance and noted. Each plot material threshed separately with the help of thresher and for removed of inert material. The data were statistically analyzed using standard statistical procedures according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on growth attributes

The growth attributes of wheat (plant height, fresh weight plant^{-1}, dry weight plant^{-1}, number of ear head (m^{-2}), number of effective tillers (m^{-2}) and total tillers (m^{-2}) were influenced due to different varieties and potassium levels. Varieties did not show any significant different in respect of plant height, fresh weight plant^{-1} and dry weight plant^{-1}, however, the maximum values of these traits was recorded K-402 followed by K-307 and the lowest in PBW-343. Similarly, the maximum number of ear head (391.20 m^{-2}), effective tillers (266.44 m^{-2}) and total tillers (317.54 m^{-2}) were recorded with PBW-343 followed by K-307 and lowest in K-402. The lowest ineffective tillers (51.10 m^{-2}) were also recorded under PBW-343. Differential behavior in growth habit of wheat varieties may be attributed to their genetic makeup. Similar results have earlier been reported by Muhammad *et al*. (2008).

Application of 80 K_2O ha^{-1} recorded the higher value of plant height (86.54 cm), fresh weight (20.96 g plant^{-1}), dry weight (19.58 g plant^{-1}) number of ear head (393.09 m^{-2}), effective tillers (269.83 m^{-2}) and total tillers (315.45 m^{-2}) which was at par with 60 kg K_2O ha^{-1} and significantly superior to 40 kg K_2O ha^{-1} and control. The improvement in vegetative growth may be attributed to important role of potassium in nutrient and sugar translocation in plant and turgor pressure of plant cells. Also potassium active numerous enzyme systems involved in formation of organic substances and in buildup of compounds such as carbohydrates. Its role in mainly cell development and in triggering young tissues or be due to that potassium is involved in plant mersitematic growth (Chhokar *et al*., 2006). This may be also due to better growth of healthy seedlings produced with application of potassium (Toledo *et al*., 2011).

Effect on yield attributes and yields

Wheat varieties differed significantly for yield attributes in terms of spike length (cm), spikelets spike^{-1}, weight spike^{-1}, grains spike^{-1}, weight of grains spike^{-1} and 1000-grain weight (Table 1 and 2). Among the wheat varieties, PBW-343 recorded higher values for all these attributes studies followed by K-307 and lowest in K-402. Similarly, seed yield, straw yield and biological yield were also highest recorded with PBW-343 followed by K-307 and lowest under K-402. The corresponding value of grain, straw and biological yield was increased to the extent of 21.92, 11.70, 15.34, 9.36 and 17.96, 10.31 per cent when compared to K-402 and K-307, respectively. Harvest index also followed similar trend.

The yield attributes *viz*., spike length (cm), spikelets spike^{-1}; weight spike^{-1}, grains spike^{-1}, weight of grains spike^{-1} and 1000-grains weight were significantly increased with increasing levels of K_2O up to 80 kg ha^{-1}. The application of 80 kg K_2O ha^{-1} gave higher value of these yield attributes which was at with 60 kg K_2O ha^{-1} and significantly superior over control and 40 kg K_2O ha^{-1}. Application of 80 kg K_2O ha^{-1} produced higher 4.43 per cent spike length (cm), 4.20 per cent spikelets spike^{-1}, 13.98% weight spike^{-1}, 13.20% grains spike^{-1}, 13.39% weight of grains spike^{-1} and 0.96%, 1000-grains weight than that of 40 kg K_2O ha^{-1}. Seed yield is the final expression of growth and yield attributing traits of the plants. This might be due to wheat variety PBW-343 produced higher growth and yield attributes

Table 1: Effect of application of potassium levels on growth and yield attributes of wheat varieties at harvest

Treatment	Plant height (cm)	Fresh weight plant^{-1} (g)	Dry weight plant^{-1} (g)	Number of ear head (m^{-2})	Effective tillers (m^{-2})	Ineffective tillers (m^{-2})	Total tillers (m^{-2})	Spike length (cm)	Spikelet spike^{-1}	Weight spike^{-1} (g)
Varieties										
PBW-343	82.18	19.88	18.53	391.20	266.44	51.10	317.54	9.32	19.91	2.62
K-402	84.58	20.47	19.23	369.44	245.05	55.79	300.84	8.56	17.86	2.35
K-307	83.50	20.24	18.93	380.97	256.42	52.96	309.38	8.87	18.55	2.44
SEm ±	1.31	0.38	0.31	2.78	2.40	1.30	2.91	0.05	0.12	0.04
CD (p = 0.05)	NS	NS	NS	5.76	4.98	2.70	6.04	0.11	0.25	0.08
Potassium levels (kg ha^{-1})										
Control	79.32	19.19	17.95	361.66	236.73	60.78	297.51	8.66	18.07	2.19
40	82.64	20.06	18.78	378.83	254.46	54.75	309.21	8.81	18.59	2.36
60	85.17	20.58	19.26	388.56	264.19	50.66	314.85	9.00	19.07	2.64
80	86.54	20.96	19.58	393.09	269.83	45.62	315.45	9.20	19.37	2.69
SEm ±	1.51	0.379	0.36	3.21	2.77	1.51	3.36	0.06	0.14	0.04
CD (p = 0.05)	3.14	0.79	0.74	6.66	5.75	3.12	6.98	0.12	0.29	0.09

Table 2: Effect of application of potassium levels on yield attribute and yield of wheat varieties

Treatment	Grain spike^{-1} (no.)	Grain weight spike^{-1} (g)	1000-grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Varieties							
PBW-343	46.30	1.83	39.42	48.89	69.78	118.67	41.20
K-402	41.67	1.63	39.13	40.10	60.5	100.60	39.86
K-307	43.30	1.70	39.23	43.77	63.81	107.58	40.68
SEm ±	0.84	0.03	0.21	0.98	1.38	2.42	0.29
CD (p = 0.05)	1.74	0.05	NS	2.04	2.86	5.02	0.59
Potassium levels (kg ha^{-1})							
Control	39.44	1.52	38.45	35.93	56.92	92.85	38.69
40	41.81	1.65	39.35	41.94	62.23	104.17	40.26
60	46.33	1.83	39.49	48.42	69.45	117.87	41.08
80	47.44	1.88	39.73	50.72	70.19	120.91	41.95
SEm ±	0.97	0.03	0.24	1.13	1.59	2.80	0.33
CD (p = 0.05)	2.01	0.06	0.50	2.35	3.30	5.80	0.68

finally reflect on dry matter of crop. Singh (2000) and Muhammad *et al.* (2008) reported similar results.

Similarly, application of 80 kg K_2O ha^{-1} gave significantly higher grain, straw and biological yield over control and 40 kg K_2O ha^{-1} but it was statistically at par 60 kg K_2O ha^{-1}. The highest grain yield of 50.72 q ha^{-1} was produced with 80 kg K_2O ha^{-1}, showing an increase of 20.93 per cent over 40 kg K_2O ha^{-1}. Similarly, application of 80 kg K_2O ha^{-1} gave straw and biological yield of 70.19 and 120.91 q ha^{-1}, registering an increase of 12.79 and 16.06 per cent, respectively over 40 kg K_2O ha^{-1}. Harvest index also significantly influenced by different levels of K_2O. Maximum harvest index (41.95) was recorded with K_2O @ 80 kg ha^{-1} which was significantly higher over control, 40 and 60 kg K_2O ha^{-1}. The data indicated that the cumulative effect of yield contributing characters, such as effective tillers plant^{-2}, spikelets spike^{-1}, grains spike^{-1} and 1000-grain weight had positive contribution to higher grain yield obtained from 80 kg K_2O ha^{-1}. Appropriate potassium nutrition with the increase in leaf area, chlorophyll and absorption of other nutrients, will increase photosynthetic capacity and yield. Although K is a co-factor for several enzymes yet its effect on starch synthesis is well established. Starch synthesis is one of the major events in grains. Therefore, availability of potassium can have a profound effect on grain development. Similar response of K on grain yield has also been reported by Dwivedi (2001), Khan *et al.* (2007).

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