Original Research Article

Effect of foliar feeding of nutrients, salicylic acid and sea weed extract on yield and yield attributes of wheat Varieties under *Tarai* region

ABSTRACT

A field experiment was conducted in the E-2 block of Norman E.Borlaug crop research centre (NEBCRC) of Govind Ballabh Pant University of agriculture and technology (GBPUA&T), Pantnagar during rabi of 2021-2022. The experiment envisages study the growth and productivity and economic feasibility wheat under variable varieties and foliar nutrition management. The experiment was laid in Factorial Randomized block design with two varieties (DBW-17&WH-1105) and five foliar spray treatments viz., no spray (control), NPK mixture at 45 & 60 DAS (FN-1), Micro-nutrients mixture at 45 & 60 DAS (FN-2), salicylic acid at 45 & 60 DAS (FN-3) and sea weed extract at 45 & 60 DAS (FN-4). Variety WH-1105 recorded higher plant height, number of tillers/m^2 and dry matter accumulation (g/m^2) than DBW-17 at 60, 90 DAS. At harvest, variety WH-1105 indicated the effective tillers/m^2, spike length, number of grains/spikes, number of spikelets/spike and grain weight per spike were higher by 2.7, 8.0, 4.6, 3.3 and 17.2%, respectively over variety DBW-17. Thousand grain weight and number of sterile spikelets/spikes was also exhibiting significant increase. Significantly higher grain yield, straw yield and biological yield were recorded under WH-1105 as compared to DBW-17 and the respective increase was 4.9, 4.3 and 5.0 percent. The net return and B:C ratio were improved by 5.6 & 5.7%, respectively at variety WH-1105 over variety DBW-17.

Keywords: Tarai, foliar feeding, nutrition

Introduction

Wheat *(Triticum aestivum* L.*)* is one of the most important food crops in the world. Wheat covers around 17 percent of the world's agricultural land area and produces 35 percent of food grain output; therefore, this crop is critical to global food security both now and in the future **(Amare *et al.*, 2014)**. It is one of the most significant cereal crops, with a total area of 225.6 million hectares and a total production of 758.3 million tones **(USDA, 2018).** India has a total land area of 30.17 million hectares and a total production of 93.50 million tones

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(**Anonymous, 2016**) and contributes around 35% to the national food basket. In terms of area coverage, India ranks first (24.13 million hectares), followed by China, while in terms of production, China ranks first (134.34 million tons), followed by India (98.51 million tons). Wheat is a relatively nutrient-dense food, having around 78 percent carbohydrate, 12 percent protein, 2 percent fat, and minerals, as well as a significant number of vitamins and minerals (**Kumar *et al*., 2011**).

Micro and macro-nutrients are crucial in agriculture for boosting crop productivity and nutrient use efficiency, as well as lowering the over use of chemical fertilizers. The crop requires a considerable amount of macronutrients, namely NPK. Nitrogen is a component of many essential chemical molecules, including protein and nucleic acids. It is a component of chlorophyll, which is the principal absorber of light energy required for photosynthesis. It is the most beneficial for plant vegetative development. Phosphorous is essential for energy transmission and protein metabolism. Potassium is an essential nutrient for starch enzyme activation, protein metabolism, stomata opening and sealing, chlorophyll synthesis, grain development, and resistance to disease and pest damage in various crops.

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Salicylic acid is a phenolic endogenous hormone chemically known as 2-hydroxy benzoic acid. It plays a significant role in reducing the impact of biotic and abiotic (environmental) stress on biochemical and physiological systems. It has also been reported that SA fails to produce cytosolic Ca fluctuations in guard cells, but SA suppresses potassium channel function, resulting in stomata closure (**Khan *et al.* 2015**). SA application suppresses Na uptake and stimulates the uptake of other nutrients (**Yildirim *et al*. 2008**).

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Sea weed extracts are frequently utilized as plant bio-stimulants because of the presence of various growth regulators such cytokinin, auxins, gibberellins, and betaines, as well as macro-nutrients like Ca, K, P, and micro-nutrients like Fe, Cu, Zn, B, Mn, Co, and Mo. Liquid sea weed extract is derived from the sap of red & brown algae. Sea weed fertilizer was found to be superior to chemical fertilizer. Application of sea weed extract has been shown to improve the wheat's ability to absorb nutrients. Additionally, seaweed sap contains a lot of potassium and phosphorus. Within a few hours of the application when used as a foliar spray, it is immediately assimilated by crop leaves. Application of seaweed extract increased wheat production and quality by 20%, according to (**Shah *et al*. 2013**). The presence of a high quantity of organic matter assists in the retention of moisture and minerals in the topsoil, making them available to roots (**Sivasankari *et al.* 2006**).

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Materials and Methods

Experimental Site

A field experiment was conducted in the E-2 block at *Norman E. Borlaug crop research Centre* (NEBCRC) of Govind Ballabh Pant University of agriculture and Should be capital letter echnology (GBPUA&T), Pantnagar, Dist. Udham Singh Nagar, Uttarakhand during the rabi season 2020- 2021. The Centre is located at 29^0 N latitude and 79.3^0E longitudes and an altitude of 243.84m above mean sea level. The research Centre falls under the foothills of "Shivalik" ranges of "Himalayan" at a narrow belt called "Tarai" that is categorized under mollisols.

List 1: Edaphic condition

Particulars	Value	Method of determination
Soil texture	Sandy loam (sand 50%, silt 30%, clay 20%)	Hydrometer method **(Deshpande *et al.*, 1971)**
pH (1:2.5 ratio, soil: water suspension)	7.2	Beckman Glass Electrode meter **(Jackson, 1973)**
Electrical Conductivity(dS/m)	0.216	Conductivity bridge **(Piper, 1966)**
Organic carbon (%)	0.78	Modified Walkley and Black method **(Jackson, 1973)**
Available N (kg/ha)	230	Alkaline $KMnO_4$, **(Subbiah and Asija, 1956)**
Available P (kg/ha)	22.1	Olsen's method **(Olsen et al., 1954)**
Available K (kg/ha)	198	Flame photometer method **(Jackson, 1973)**

Design and Experimental Details

The experiment was laid down in a **Factorial-RBD** with three replications. The treatments consist of two different varieties (DBW-17 and WH-1105) with 5 levels of foliar feeding and the treatment combinations are as follows-

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T_1= DBW-17 with no spray.

T_2= DBW-17 with foliar spray of NPK @ 2.0%.

T_3= DBW-17 with foliar spray of micro nutrient mixture @ 2.0g/l.

T_4= DBW-17 with foliar spray of spray salicylic acid @ 400ppm.

T_5= DBW-17 with foliar spray of seaweed extract @ 0.16%.

T_6= WH-1105 with no spray.

T_7= WH-1105 with foliar spray of NPK @2.0%.

T_8= WH-1105 with foliar spray micro nutrient mixture@2g/l.

T_9= WH-1105 with foliar spray salicylic acid @400ppm.

T_{10}= WH-1105 with foliar spray see weed extract @0.16%.

Treatment execution

After pre sowing irrigation field was prepared. The layout was done manually as per Factorial Randomized Block Design (FRBD). The recommended dose of fertilizer150:60:40 NPK kg/ha was applied. The recommended dose of fertilizer was applied as the basal per plot in the furrows. Then fertilizer was mixed into the soil manually using furrow opener. After layout of the field prior to sowing, fertilizers were applied through NPK mixture (12:32:16), urea and MOP. The calculated number of seed was sown per plot and covered by the soil. Finally, the soil was compacted using a manual roller to ensure proper contact between seeds and soil. After emergence of the crop (15 DAS) with the help of spade, the bunds and irrigation channels were made. The foliar sprays were done twice respectively, at tillering (45 DAS) and jointing stages (60 DAS) using 500-liter volume of water. The NPK (18:18:18) mixture, Micro nutrient mixture, salicylic acid and sea weed extract was sprayed at the rate of 2%, 2g/l, 400ppm and 0.16%, respectively.

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Results and Discussion

Yield attributes

The data pertaining to yield attributing characters such as number of spikes/m^2, spike length and number of spikelets/spikes is given in Table-1.

No. of spikes /m^2

The number of spikes was significantly higher in variety WH-1105 (352/m^2) as compared to DBW-17 (337/$m^{2)}$. The ability of a variety to produce more spikes, particularly those that are initially forming primary tillers, may be the most important contributing factor to the production of additional spikes. Furthermore, the variety's tillering and spike-bearing ability has been influenced by its genetic composition.

All foliar nutrition treatments produced significantly higher no. of spikes/m^2 than the control (310). The maximum spikes (370/m^2) were noticed for FN-1, which was at par with FN-3 (363/$m^{2)}$. FN-1 and FN-3 produced significantly higher spikes/m^2 than FN-2 and FN-4. Further spikes no./m2 did not vary significantly between FN-2 (342) and FN-4 (340). These findings are consistent with those obtained by **Nadim *et al.* (2011)**. Foliar nutrition, by balancing nutrient delivery, helps the crop in performing its functions to the best of its ability. As a result, tiller production increases, and the spike number increases. Higher spikes are due to increased dry matter build-up, which is a precursor to higher yield qualities. Application of salicylic acid was the next to affect the no. of spikes followed by micronutrient application. These findings coincide with observations of **Amin *et al.* (2008).** Salicylic treatments in increasing dry matter of wheat plants. The increase of dry matter in the wheat plant might be attributed to an increase in the primary tillers and spikes.

Spike length

The spike length was affected significantly due to the nature of variety. The spike length of the variety WH-1105 (13.1 cm) was found to be 8% longer than the spike length of DBW-17 (12.3 cm). It's possible that WH-1105 longer spikes are attributable to its genetic makeup. Higher spike length in WH-1105 plots is consistent with the findings of **Rathwa *et al.* (2018).** All foliar nutrition treatments produced significantly higher spike length than the control (11.1 cm). The maximum spike length (13.9 cm) was noticed for FN-1, which was at par with FN-3 (13.2 cm). FN-1 and FN-3 produced significantly higher spikes/m^2 than FN-2 and FN-4. Further spike length did not vary significantly between FN-2 (13.0 cm) and FN-4(12.8). The percent difference in FN-1, FN-3, FN-2, and FN-4 over control was 25.2, 18.9, 17.1, and 16.2percent, respectively. Higher spike lengths due to foliar nutrition are similar to the findings of **Hendawey (2015).** The application of salicylic acid was the next to affect the

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Number of spikelets/spikes

The number of spikelets/spikes is affected significantly by varietal traits. The variety WH-1105 (18.7) spikelets/spike had the highest count, which was 3.3 percent higher than DBW-17 (18.0 spikelets/spike). All foliar nutrition treatments produced significantly higher spikelets/spike than the control (16.8). The maximum spikelets/spike (13.9 cm) was noticed for FN-1, which was at par with FN-3 (13.2 cm). FN-1 and FN-3 produced significantly higher spikelets/spike than FN-2 and FN-4. Further spikelets/spike did not vary significantly between FN-2 (13.0 cm) and FN-4(12.8). When FN-1, FN-3, FN-2, and FN-3 were compared to control, the percent difference was 19.1, 11.4, 3.0, and 2.9%, respectively. **Jamal *et al.* (2006)** found that micro and macro nutrient-treated plots had an increased number of spikelets/spikes. Application of salicylic acid was the next to affect the spikelets/spike followed by micronutrient application.

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Table-1: Effect of different treatments on yield attributing characters of wheat

Treatment	No. of spikes/m^2	Spike length(cm)	No.of spikelets/ spike
Variety			
DBW-17	337	12.3	18.0
WH-1105	352	13.1	18.7
SEm±	3.8	0.3	0.3
CD at 5%	11	0.8	1.0
Foliar nutrition			
Control	310	11.1	16.8
FN1	370	13.9	20.1
FN2	342	13.0	18.8
FN3	363	13.2	19.0
FN4	340	12.4	17.2
SEm±	6.1	0.4	0.5
CD at 5%	18	1.3	1.5

Number of grains per spike

The data pertaining to Number of grains/spikes is given in Table-2. The varieties had a significant influence on the number of grains per spike, but the foliar nutrition also. With a 4.6 percent difference, the variety WH-1105(52.7 grains/spike) better performed than DBW-17 (50.4 grains/spike). The variable response of cultivars to the number of grains/spikes is analogous to the findings of **Gupta *et al.* (2020).** The difference might be owing to its longer panicles, as seen in WH-1105.

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All foliar nutrition treatments produced significantly higher number of grains/spike than the control (48.6). The maximum number of grains per spike (54.7) was noticed for FN-1, which was at par with FN-3 (52.0). FN-1 and FN-3 produced a significantly higher number of grains per spike than FN-2 and FN-4. Further number of grains per spike did not vary significantly between FN-2 (51.5) and FN-4(50.9). The percent of the difference seen with FN-1, FN-3, FN-2, and FN-4 treatments over the control was 12.5, 7.0, 5.9, and 4.7 percent, respectively. This growth might be attributed to external macro and micronutrient foliar feeding.

These findings are consistent with the findings of **Jamal *et al.* (2006),** who observed an increase in the number of grains per spike and grain weight per spike with varied foliar nitrogen, phosphorus, and potassium concentrations.

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Grain weight/spike

The data pertaining to grain weight/spike is given in Table-2. **Yadav *et al.* (2017)** discovered differences in grain weight/spike among wheat genotypes. All foliar nutrition treatments produced significantly higher number of grain weight/spike than the control (1.67). The maximum number of grain weight/spike (2.10) was noticed for FN-1, which was at par with FN-3 (1.95). FN-1 and FN-3 produced a significantly higher number of grain weight/spike than FN-2 and FN-4. Further number of grain weight/spike did not vary significantly between FN-2 (1.88) and FN-4(1.80). the percent of the difference with FN-1, FN-3, FN-2, and FN-4 over the control was 23.5, 8.4, 7.8, and 7.2 percent, respectively. This increase might be attributed to foliar spraying with increased macronutrients and micronutrients. Dry matter collected during the vegetative phase is translocated during the reproductive phase, resulting in a higher degree of yield parameters, notably more and heavier grains. Our findings are comparable to those of **Rogalski (1994),** who found that foliar NPK treatment improved grain weight. Application of salicylic acid on wheat enhanced the grain weight/spike by 13.5% **according to Karim and Khursheed (2011).**

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1000 grain weight

The data pertaining to 1000 grain weight is given in Table-2. The 1000 grain weight was significantly affected by variety and foliar nutrition. The Variety WH-1105 had a higher 1000 grain weight (40.1 g) as compared to DBW-17 (39.0 g). The difference between these was found to be 2.8%.

All foliar nutrition treatments produced significantly higher number of 1000 grain weight than the control (37.9 g). The maximum number of 1000 grain weight (41.5 g) was noticed for FN-1, which was at par with FN-3 (40.2 g). FN-1 and FN-3 produced a significantly higher number of 1000 grain weight than FN-2 and FN-4. Further number of 1000 grain weight did not vary significantly between FN-2 (39.4 g) and FN-4(38.8 g). The percent of the difference in FN-1, FN-3, FN-2, and FN-4 over the control was 9.4 percent, 6.0 percent, 4.0 percent, and 2.4 percent, respectively. These findings matched those of **Fillipove and Mangova (1992),** who observed a rise in grain weight after foliar nitrogen, phosphorus, and potassium treatment. Application of salicylic acid was the next to affect the 1000 grain. These results with salicylic acid are similar to findings of **Yavas and Unay (2016).**

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Table-2: Effect of different treatments on yield attributing characters of wheat.

Treatment	No. of grains/ spike	Grain wt./spike (g)	1000 grain wt. (g)
Variety			
DBW-17	50.4	1.75	39.0
WH-1105	52.7	2.00	40.0
SEm±	0.7	0.05	0.2
CD at 5%	2.0	0.15	0.7
Foliar nutrition			
Control	48.6	1.67	37.9
FN1	54.7	2.10	41.5
FN2	51.5	1.88	39.4
FN3	52.0	1.95	40.4
FN4	50.9	1.80	38.8
SEm±	1.1	0.08	0.4
CD at 5%	3.2	0.23	1.1

Yield Studies

Grain yield

The data pertaining to grain yield is given in Table-3. The grain yield was significantly affected by the varieties. The variety WH-1105 recorded higher grain yield (45.1 q/ha) as compared to variety DBW-17 (43.0 q/ha). The yield difference between the WH-1105 and DBW-17 was 5.0 percent. The higher grain yield of WH-1105 resulted from its varietal character and canopy structure, producing higher dry matter, growth and yield attributes.

All foliar nutrition treatments produced significantly higher Grain yield than the control (39.3 q/ha). The maximum grain yield (46.3 q/ha) was noticed for FN-1, which was at par with FN-3 (45.6 q/ha). FN-1 and FN-3 produced a significantly higher Grain yield than FN-2 and FN-4. Further, grain yield did not vary significantly between FN-2 (44.0 q/ha) and FN-4(43.2 q/ha). The percent difference in yield with FN-1, FN-3. FN-2 and FN-4 over the control was 13.4 percent, 10.2 percent, 6.7percent, and 4.47 percent increase, respectively. **Gul *et al.* (2006)** observed that foliar nitrogen, phosphorous, and potassium treatments enhanced wheat grain yield. Application of salicylic acid was the next to affect grain yield followed by micronutrient application. The best figures were found in variety WH-1105 with FN-1(49.6 q/ha) followed by variety WH-1105 with FN-3 (46.03 q/ha).

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Straw yield

The data pertaining to straw yield is given in Table-3. The variety WH- 1105 (73.1 q/ha) was resulted higher straw yield as compared to DBW-17 (70.0 q/ha) due to the varietal character and its higher density of the canopy. The difference in the straw yield due to only by choosing varieties was recorded 4.3 percent. Higher tillering along with plant height might have contributed to higher straw yield in WH-1105. Similar results of an increase in straw yield were observed by **Nayak *et al.* (2012).**

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All foliar nutrition treatments produced significantly higher straw yield than the control (67.5 q/ha). The maximum straw yield (73.9 q/ha) was noticed for FN-1, which was at par with FN-3 (73.8). FN-1 and FN-3 produced a significantly higher Grain yield than FN-2 and FN-4. Further straw yield did not vary significantly between FN-2 (72.3 q/ha) and FN-4(70.1 q/ha). The percent difference with FN-1, FN-3, FN-4, and FN-2 over the control was 9.8 percent, 9.5percent, 6.3 percent, percent, and 5.8percent, respectively. The increase in production of higher straw yield might be due to the production of superior characters are plant height, higher dry matter, and a greater number of tillers/m² in foliar nutrition plots. Similar results were observed with an increase in straw yield by application of macro and micronutrient mixtures have been given by **Khalid** ***et al.*** **(2004) and Bhujade** ***et al.*** **(2016).** Application of salicylic acid was the next to affect straw yield followed by micronutrient application. Same results with salicylic acid were found by **El-Nasharty** ***et al.*** **(2019).**

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Biological yield

The data pertaining to biological yield is given in Table-3. The Biological yield was found significant due to varieties. The variety WH- 1105(117.6 q/ha) resulted in higher biological yield as compared to DBW-17 (112.8 q/ha), which might be result due to the genetic varietal character and it can further be supported by its higher canopy density.

All foliar nutrition treatments produced significantly higher biological yield than the control (106.8 q/ha). The maximum biological yield (120.2 q/ha) was noticed for FN-1, which was at par with FN-3 (119.4 q/ha). FN-1 and FN-3 produced a significantly higher biological yield than FN-2 and FN-4. Further, biological yield did not vary significantly between FN-2 (116.3 q/ha) and FN-4 (113.3 q/ha). The percent of the difference in biological yield with FN-1, FN-3, FN-2 and FN-4 over the control was 12.4 percent, 10.4 percent, 6.5 percent and 5.7 percent, respectively. The production of higher biological yield might be attributed due to balanced and optimum availability of micro and macro nutrients, attributed towards higher crop growth, and recorded higher grain and straw yields. The results are in agreement with the experimental findings of **Rajput** ***et al.*** **(1995)** due to foliar spray of nitrogen and **Esfandiari (2016).** Application of salicylic acid was the next to affect the biological yield followed by micronutrient application. **Sharifizad** ***et al.*** **(2013)** was found same results with salicylic acid.

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Table-3: Effect of different treatments on productivity characters of wheat

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)
Variety			
DBW-17	42.8	70.0	112.8
WH-1105	44.5	73.1	117.6
SEm±	0.5	0.7	1.2
CD at 5%	1.5	2.5	3.6

Control	39.3	67.5	106.8
FN1	46.3	73.9	120.2
FN2	44.0	72.3	116.3
FN3	45.6	73.8	119.4
FN4	43.2	70.1	113.3
SEm±	0.8	0.9	1.9
CD at 5%	2.3	2.5	5.7
Interaction			
CD at 5%	S	NS	NS

Conclusion

From the results of the present study, it can be concluded that variety WH-1105 exhibited an edge over DBW-17 in terms of growth and productivity. Foliar nutrition with 2% NPK (twice) was most viable option to supplement RDF in wheat followed by salicylic acid. Over all variety WH-1105 along with foliar spray of 2% NPK gave the maximum productivity (46.3 q/ha).

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